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NOTICE.

ANNAPOLIS, MD., *February* 20, 1892.

Having carefully read the three essays submitted in competition for the prize offered by the U. S. Naval Institute for the year 1892, we have the honor to announce that, in accordance with Article XI. of the Constitution, the prize is awarded to the essay bearing the motto "Me, me adsum qui feci," on Torpedo-boats, their Organization and Conduct.

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Ensign, U. S. Navy.
Members, Board of Control.

NOTICE.

It is earnestly desired that all MSS. of discussions on any articles in this number be forwarded to the Secretary and Treasurer not later than September 15, 1892.

By direction of the Board of Control.

H. G. DRESEL,
Ensign, U. S. Navy, Secretary and Treasurer.

THE PROCEEDINGS

OF THE

UNITED STATES NAVAL INSTITUTE.

Vol. XIV., No. 2. 1892. Whole No. 62.

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PRIZE ESSAY FOR 1892.

MOTTO:—"*Me, me adsum qui feci.*"

TORPEDO-BOATS: THEIR ORGANIZATION AND CONDUCT.

BY WM. LAIRD CLOWES,

Associate and Honorary Fellow of King's College, London.

When the automobile torpedo first appeared as a possible factor in naval warfare, its value, like that of the majority of new and startling inventions, was generally misapprehended. The weapon, it was at first widely believed, would not only create novel conditions, but would also render vain and useless all the ancient principles by which warlike operations at sea had been previously conducted. Large craft of all kinds—the swift light cruiser and the slow heavy battleship alike—were to go down at once before the diminutive torpedo-boat, which, besides undertaking the scouting and commerce-destroying work that was of old performed by frigates, corvettes and sloops, was to bear a conspicuous part in the defense of coasts, harbors and estuaries, to do all the duties of the dispatch-vessel, to take a leading share in fleet-actions, and, in fine, to carry everything before it and to be irresistible.

It is not necessary here to enquire how these exaggerated ideas of the mission of the torpedo and the torpedo-boat arose; but it may fairly be suggested that the veil of mystery which by all the earliest users of it was thrown around the Whitehead torpedo did much towards fostering the misapprehensions. Even of the officers, only a select few were permitted to form any judgment of what the torpedo actually was. The rest, familiar merely with the outside of the weapon, were taught to regard it as a kind of fetish, the powers of which, if unknown, were also probably unlimited. In the British service, at that period, the amount of secrecy observed in connection with the Whitehead was, looking to the circumstances, positively amusing. Mr. Whitehead has always been quite willing to sell his torpedo—and so to convey its secret—to any state, corporation, or individual that may choose to pay the price demanded; yet whenever a torpedo had to be examined, cleaned or repaired on board a British man-of-war, a canvas screen was rigged up for the purpose, sentries were posted, and fully as much care was taken to prevent intrusion by the officers and men in general as could have been taken had a goddess been enjoying a bath upon the tabooed stretch of deck. In the meantime, the torpedo-boat was almost equally unfamiliar, save to a small class of specially trained people.

It is only natural that, amid such surroundings, the torpedo was misunderstood, and the torpedo-boat was systematically used for purposes for which it was in no way fitted. For several years during the British and French summer manœuvres, for example, the torpedo-flotillas accompanied the fleets to sea and were for long consecutive periods entirely dependent upon their larger consorts for shelter as well as for fuel and stores. Then came the reaction. Torpedo-boats were seen to be unsuitable for keeping the sea, and torpedoes, as they were run for practice, were observed to travel very inaccurately. It was, therefore, concluded—but too hastily—that torpedo-boats, not being able to keep the sea, must be almost useless; that no torpedoes were to be depended upon for accuracy; and that even if they were to be depended upon for accuracy, they could only be discharged with effect either from the shore or from ironclads and large craft. But fresh experiments were made; torpedoes and torpedo-vessels were greatly improved; and the pendulum of opinion, having thus swayed from one extreme to the other, now tends, in the absence of new disturbing influences, to gradually settle to rest at

some point between the two. It is the object of the following paper to discover, with the aid of such indications as have been afforded by torpedo-boat manœuvres, and by warlike operations in which torpedoes and torpedo-vessels have played a part, what that point is likely to be, and to show what are the true uses and limitations of the new naval arm.

The subject is not one that at present very nearly touches the United States, a country which scarcely possesses a torpedo-flotilla; but it is every day becoming more important; and in the unhappy event of the outbreak of a war, there would, I suspect, be more discussions about the handling of torpedo-boats, and more excitement about the exploits of them, than about the handling and exploits of craft of any other class. The torpedo-boat is essentially a vessel for a country with a long and deeply indented coast-line, with foreign ports not very far removed from her shores, and with historical traditions which render her more desirous of self-defense than of aggression. I think, therefore, that this paper is neither impertinent nor inopportune.

The modern automobile torpedo is a very different weapon from the Whitehead of six or seven years ago. How different it is can scarcely be realized save by one who has had the handling of both. The new one may fairly claim to be a weapon of precision; the old one—no matter what may have been its claims—was in reality nothing of the sort. Sometimes, when discharged, it traveled in a right line; oftener it did not. It was, moreover, slow, and it carried a comparatively small explosive charge. The latest Woolwich torpedo, on the other hand, is a triumph of light construction, speed, accuracy and power. Its engines, which are capable of developing fifty-two horse-power and making 2000 revolutions a minute, will drive it, up to 700 yards, at a speed of close upon thirty knots; and I have seen it travel in smooth water with fair speed and considerable accuracy as far as 1400 yards. As for its charge, it is so great that, if it be exploded in contact with the bottom of a ship, the vessel can scarcely fail to be put out of action. It may therefore be assumed that the modern automobile torpedo will do all the work that is expected of it, provided that it be properly prepared and properly discharged, that it be used at a reasonable range, and that there be no obstructions between the weapon and the target. Having assumed so much, it is not necessary to devote special attention to the torpedo itself. The more interesting question is: How best shall we bring the tor-

pedo into a position whence we may dispatch it, under all possible advantages, to do its work in war-time? And that is practically the question which I purpose to endeavor to answer.

But before making the attempt, I should premise that for several years I have enjoyed perhaps exceptional opportunities of seeing torpedoes and torpedo-boats at work under the conduct of those who are most familiar with the best types of both. I have witnessed the discharge of hundreds of unloaded torpedoes of all "marks" and designs, and of several loaded ones. I have watched experiments with all kinds of tubes, submerged and above water. I have been afloat in torpedo-vessels and torpedo-boats of all types and in all weathers. I have been present at numerous experimental torpedo-attacks, both by day and by night. I have observed the behavior of torpedo-boats under all conditions, and of their crews under all states of discomfort, excitement, danger and hurry. I have conversed or corresponded with the most distinguished torpedo specialists in Europe. And, finally, my experience has not been limited to the torpedoes and torpedo-flotillas of any one nation, and, though it has not of course extended to those of all countries, it has brought me into contact with several which admittedly rank among the best in the world to-day.

I have already said that in the early days of torpedo-boats they were regarded as proper accompaniments for a fleet at sea. In 1885, for example, when the British Particular Service Squadron, under Sir Geoffrey Hornby, manœuvred around the coasts of the British Islands, a squadron of eight torpedo-boats went with it, each boat being attached to an ironclad, and drawing from her the needful supplies of coal, water, stores and food. The boats were of the two following types:

	Displ. in tons.	Length.	Beam.	Mean Draught.	Extreme Speed.
6 of	32	87′ 0″	10′ 0″	4′ 0″	18 knots.
2 of	63	113′ 0″	12′ 6″	5′ 7″	20 knots.

At sea the boats were a failure; and, seeing that they met with some rather dirty weather, it has always been to me a matter of astonishment that they got back to their ports without serious disaster. They could sometimes make so little progress that they delayed even ships that had an extreme speed of no more than 10 knots; they were a continual source of trouble and anxiety to all engaged, and they were abodes of misery to those who were in them. On

the 9th and 10th of June, while steaming at a very easy speed on a calm sea, three of them broke down. On July 11, off the northwest coast of Ireland, in a brisk breeze from the westward, the senior officer in charge of four of the boats had to request permission to take them all inshore. And on July 17th and 18th, during half a gale in the Irish Sea, some of the boats behaved so badly that their crews, able neither to eat nor to sleep, and overtaken by most alarming sickness, were completely worn out and prostrated. What was attempted by England in 1885 was attempted by France in 1886, and in the following years by both nations. The British, having found that their 113 ft. boats were not sea-keepers, tried 125 ft., 127½ ft., and 130 ft. boats. The French tried an even greater number of types, ending with the 151 ft. boats of the Ouragan class. But long before the series of experiments had been carried far, it was pretty generally recognized that the torpedo-boat, as distinct from the torpedo-boat-catcher or torpedo-gunboat, was unsuited for keeping the sea; and that if sea-keeping torpedo-vessels were required, they must be of 250 tons' displacement at least, and might, with advantage to the comfort and condition of their crews, be considerably larger. This conclusion had the effect of creating a new species of small craft, midway between the torpedo-cruiser and the torpedo-boat. To the new craft, the torpedo-gun-vessel, has been assigned most of the work which, it was originally supposed, the torpedo-boat was capable of; and the torpedo-boat, being no longer needed to serve as a scout and dispatch-vessel, fell into some neglect until her merits and her potentialities were developed in a new direction, first to a slight extent by the Germans, and then, especially during the naval manœuvres of 1890, by the British.

What may be called the new view of the proper functions of the torpedo-boat regards that little craft as merely a quick and decisive raider from a base, and not as a vessel from which any kind of sustained effort must be demanded. The torpedo-boat's business is to strike, like a bolt from the blue, in the most unexpected quarters; to be always in perfect readiness for a few hours of rough hard work under extreme pressure; to appear unannounced in distant places; to vanish unpursued and unseen; and never to expose herself unnecessarily either to the violence of the sea or to the attention of the enemy. Yet this new view—which is, I am persuaded, the right one—is not yet exclusively adhered to anywhere. In Germany, during the combined manœuvres of 1890, I saw torpedo-boats in the Nübel-

Noor engaged in an entirely inappropriate artillery duel with the field batteries of the Ninth Army Corps. At Kiel, in 1891, other boats made an attempt to rush past forts which were already alarmed and expecting the attack. And, during the British manœuvres of 1891, boats were on several occasions kept too long at sea, so that their people were unduly fatigued; and they were, moreover, so handled that they were never properly withdrawn from the enemy's observation, and were, in consequence, never in a position to deliver a real surprise attack. It was in the British manœuvres of 1890 that the rudimentary principles of the new view were most consistently acted upon; and although the story of the raid from Guernsey upon the fleet at Plymouth has been told more than once, I must here tell it again, if only because that raid seems to me to mark the beginning of a new departure which may some day lead to startling results.

During the British naval manœuvres of 1890 hostilities began at 5 p. m. on the 8th of August. At that hour the positions of the squadrons, so far as they need here be considered, were as follows:

A. Within Plymouth Breakwater. The battleships Northumberland (flag), Anson (flag), Rodney, Inflexible, Invincible, Triumph, Hotspur, Black Prince, and Hero. The armored cruisers Narcissus, Galatea, and Shannon. The cruisers Iris, Thames, Mersey, Medusa, Inconstant, Mohawk, and Racoon. The special-service vessel Hearty. The sloop Basilisk. The torpedo-gun-vessels Speedwell and Spider.

C. At the Channel Islands. The first-class torpedo-boats:

No.	Displ. in tons.	I. H. P.	Length.	Beam.	Mean Draught.	Extreme Speed.
51	64	700	127′ 6″	12′ 6″	6′ 3″	20.5 knots.
55	64	700	127 6	12 6	6 3	20.5 knots.
57	64	700	127 6	12 6	6 3	20.5 knots.
58	64	700	127 6	12 6	6 3	20.5 knots.
59	64	700	127 6	12 6	6 3	20.5 knots.
81	125	1387	150 0	17 6	7 4	20.7 knots.
82	95	1160	130 0	13 6	7 0	22.5 knots.
86	95	1160	130 0	13 6	7 0	22.5 knots.
87	95	1160	130 0	13 6	7 0	22.5 knots.

Sir George Tryon, commander-in-chief of Squadron A, was not permitted, under the rules of the manœuvres, to proceed with his fleet to sea until 5 p. m. on the 9th of August. Being apparently uncertain whether this restriction tied the hands of the senior officer of the opposing Squadron C, as well as his own hands, he, at a quarter

past eleven p. m. on the 8th, made the general signal, "Although I consider my hands tied as yet, still we are at no great distance from torpedo-boats; therefore keep a good lookout and have a few guns ready."

This signal was a very injudicious one. Hostilities had commenced and the enemy was at liberty to act when he would. But if there had been the smallest doubt in his mind upon the subject, Sir George should have signaled either: "According to my reading of the rules, no attack is legitimate to-night, and therefore torpedo-boats are not to be treated as enemies." Or: "Although, according to my reading of the rules, no attack is legitimate to-night, there is likely to be one, and all suitable measures must be adopted to ward it off and to repel it." The injunction "have a few guns ready," while it prevented the Admiral from afterwards claiming that he was not prepared, was a half-hearted order. It may perhaps seem frivolous to discuss the matter here, yet, since it is yearly growing more and more obvious that even when there is only the remotest risk of war, no possible precautions should be neglected, it is, I venture to think, worth while calling attention to it. All else that Sir George did was to send three cruisers to scout in the chops of the Channel, without special reference to the force at the Channel Islands.

The torpedo-boats "at no great distance" were at Guernsey, which, as the crow flies, is about 100 nautical miles from Plymouth Breakwater. Having regard to the state of the sea at the time, the distance may be considered as equal to between six and seven hours' steaming at the boats' best attainable speed. The senior officer at Alderney was Commander H. D. Barry, who, I believe, called to his counsel Lieutenants F. C. D. Sturdee and Lionel de L. Wells. I mention the names because to these officers entirely belongs the credit for what was done.

Commander Barry, whose headquarters were at Alderney, had already determined to attack Squadron A at its anchorage as soon as possible after the beginning of hostilities, and he planned two successive onslaughts: one, under Lieutenant Wells, to be made by Nos. 82, 86 and 87; and the other, to be delivered two hours later, under Lieutenant Sturdee, by Nos. 51, 55, 57, 58, 59 and 81.

I was on board one of the ships of Squadron A, and, being fully convinced that an attack would take place, did not leave the deck after about eleven o'clock p. m. The battleships and cruisers lay in four lines, at a distance of two cables, parallel with the breakwater,

the line nearest to the breakwater being composed of the Northumberland, Rodney, Anson, and Black Prince. The other big ships, except the Narcissus, Galatea, and Iris (which had been dispatched to the westward at half-past nine), formed the remaining three lines, and the small craft lay by themselves in Cawsand Bay. No vessels had their nets down; there were no search-lights in use on the breakwater or elsewhere; there were no booms, obstructions, or mine-fields at either entrance to the Sound, and there were neither cruisers nor picket-boats specially watching for the torpedo-boats which were "at no great distance." On the other hand, there was a good lookout, "a few guns" were ready, and the night was clear and light.

Lieutenant Wells, who had been lying with his division at St. Peter Port on the east side of Guernsey, started at a little before 6 p. m.*—as soon, that is, as the declaration of war had reached him. Proceeding at between 16 and 17 knots and in open order, he sighted the Start Light before midnight, and soon afterwards increased speed to 19 knots. Shortly after 2 a. m., in column of line ahead, he entered the Sound by the eastern entrance, next to which lay the Black Prince. The torpedoes for use were provided with collapsible heads of soft copper. On both sides the official arrangements for timing were very bad, and this fact naturally led to considerable conflicts of evidence as to what occurred: but my own observation convinces me that the boats were not sighted from the ships until they were all within the breakwater, and that, from the moment of the firing of the first gun to the moment when the last of the boats had discharged her torpedo, barely two minutes elapsed. As I had only an ordinary watch, I do not pretend to have been able to measure by seconds. It should here be noted that the rules placed the boats at no small artificial disadvantage. Firstly, although each boat had three tubes, and could have fired three torpedoes almost simultaneously, she was permitted only to fire one. Secondly, after firing, she was required to remain on the spot to pick up her weapon, thus getting in the way of the boat astern of her.

Owing to the conflict of evidence, no claims on either side were allowed by the umpires; but No. 86 claimed the Black Prince, and No. 87 claimed and admittedly hit the Invincible. The Black Prince denied that she had been struck; but the Anson, which was not claimed, was admittedly struck—possibly by the torpedo that was meant for the Black Prince, her next ship. No. 82's torpedo, aimed, like that of No. 86, at the Black Prince, had a leaky air-chamber

and failed to run. No. 82 then collided with the Black Prince and was so damaged as to be unfit for further sea-work, though she might still, of course, have discharged her second and third torpedoes at the ships around her.

So much for the bare facts of Lieutenant Wells' attack. Limited though the torpedo-boats were in their operations, there is in my mind very little doubt that they are now entitled to claim that they put out of action the first-class battleship Anson and the second-class battleship Invincible; which two vessels represented at the time an expenditure of very nearly 5,900,000 dollars, and had on board over 1000 officers and men. Supposing the whole of the attacking force to have perished, less than 300,000 dollars and only 57 lives would have been thrown away. And it is worthy of consideration that while new torpedo-boats may be built in three months, new battleships require three years. On board the ships there was, if not confusion, at least lack of system. Guns were fired long after the smoke of previous discharges had effectively shrouded the moving boats; and although it was a light night, the search-lights, which might have been very well dispensed with, were turned on and flashed hither and thither without much method, until one's eyes were unable to distinguish anything. As an eye-witness wrote next day: "It was fairly easy to follow the motions of the daring little craft until the ships, by signal from the Admiral, turned their electric-lights on. Thenceforward all was doubt and confusion, for there is nothing more perplexing than the flashing of search-lights at night." I feel sure that the influence of the lights must, upon the whole, have been as favorable to the attack as it certainly was unfavorable to the defense; and had the boats been permitted to discharge three torpedoes apiece, instead of but one, I see no reason why they should not have effected three times as much damage as they did effect.

Lieutenant Sturdee left his anchorage at, I believe, about 7 o'clock, and, steaming more slowly than Lieutenant Wells, entered the Sound by the western entrance at a little before 4 o'clock. He kept well under the land above Cawsand Bay, and was to some extent further sheltered by one or more large steamers that were going out; but, on the other hand, the defense, knowing that three boats only had attacked with the first division, and that many more were at Commander Barry's disposal, was now—or at least should have been—perfectly prepared. Nevertheless, No. 81 torpedoed the

Northumberland within a minute of the firing of the first gun. No. 58 did the same with the cruiser Inconstant. No. 57 discharged her weapon at the Invincible, but it failed to run. No. 59 aimed at the Northumberland, but missed her and struck No. 51, which seems to have meanwhile torpedoed the already damaged Inconstant. The sixth boat, No. 55, was troubled with hot bearings ere she could enter the Sound, and, attacking independently through the eastern entrance, was discovered by a guard-boat. Her commander declared that guns were fired and search-lights turned in every direction save that of his craft, and that his torpedo struck the Invincible. I saw this attack and am inclined to agree with him. Admitting, therefore, such claims as I conceive to be well-founded, I add the third-class battleship Northumberland and the second-class cruiser Inconstant to the number of A's ships put *hors de combat*, and, assuming that even all the torpedo-boats perished in the two affairs, place the total bill of damage for the night's work at:

	A's Losses.			C's Losses.	
	Value Dollars.	Men.		Value Dollars.	Men.
Northumberland	$4,030,000	688	Nine Torpedo-		
Anson,	3,625,000	524	boats,	$900,000	163
Invincible,	2,270,000	482			
Inconstant,	2,275,000	608			
	$12,200,000	2,302		$900,000	163

The umpires, confused by the contradictory nature of the numerous accounts, and unable to solve the difficulty in any other manner, declined to give any decision upon the claims of either side; but they did say, in their report, that "the tactics of the torpedo-flotilla operating from Alderney, as a distant base, were well planned and efficiently carried out during the early part of the manœuvres, notably in the attack upon A fleet in Plymouth Sound on the night of the 8th–9th of August."

Another instructive series of torpedo-boat manœuvres was carried out in British waters in the summer of 1891. They were, it appears to me, far less ably planned than the operations which I have just described, but, in some points at least, they were even more suggestive. I give them, as before, from notes made at the time.

War between the Red and Blue Squadrons was declared at noon on Wednesday, July 22. At that hour the disposition of the hostile forces was, I believe, as follows (see following page):

Red Squadron.

Armored Vessels.	Displ. in tons.	Armament.	Estimated Sea Speed.	Men.	
Shannon	5390	2–10 in. M. L.; 7–9 in. M. L.; 10 Q. F. and M	10.5 K	446	at anchor, Dale Roads, Milford Haven, with nets out.
Hotspur	4010	2–12 in. M. L.; 2–6 in. B. L.; 13 Q. F. and M	10.0 K	233	
Northampton	7630	4–10 in. M. L.; 8–9 in. M. L.; 4–4 7 in. Q. F. 24 Q. F. and M.	11.5 K	569	
Unarmored Cruiser.					
Barracouta	1580	6–4.7 in.; 6 Q. F. and M	13.5 K	156	Dale Roads, Milford Haven, ready to proceed to sea.
Torpedo Gun Vessels.					
Seagull	735	2–4.7 in.; 4 Q. F	16.5 K	86	
Spider	525	1–4 in.; 6 Q. F	15.0 K	63	
Skipjack	735	2–4.7 in.; 4 Q. F	16.5 K	86	
Gossamer	735	2–4.7 in.; 4 Q. F	16.5 K	86	
Rattlesnake	550	1–4 in.; 6 Q. F	17.0 K	63	

Blue Squadron.

Torpedo-depot ship Hecla and 3 first-class torpedo-boats, at Carrickfergus.
Special-service vessel Magnet and 2 first-class torpedo-boats, at Carlingford.
Battleship Belle-isle and 3 first-class torpedo-boats, at Kingstown.
Special-service vessel Traveller and 3 first-class torpedo-boats, at Wicklow.
" " " Hearty and 3 " " " " Wexford.
Torpedo gun-vessel Curfew and 6 " " " " Waterford Harbor.

The "Blue" torpedo-boats were Nos. 25, 33, 42, 45, 52, 53, 55, 57, 58, 59, 60, 65, 67, 73, 74, 75, 82, 83, 84 and 85. The vessels with them were stationary.

The Red Squadron was under Captain S. Long, who flew a broad-pennant in the Barracouta; the Blue was under Rear-Admiral Erskine, senior officer at Queenstown, Capt. J. Dunford, of the Hecla, directing operations afloat, and Commander Barry, the projector of the raid upon Plymouth Sound, being in the Curlew.

In the leading idea, England and Scotland, within certain limits which it is unnecessary here to define, were supposed to be at war with Ireland. To the former belonged the Red and to the latter the Blue Squadron. Red's armored vessels were taken to represent a fleet of battleships which was awaiting opportunities to annoy Blue's ships and coasts. Blue's flotilla was taken to be a hostile force which might be expected to repeat against Red the tactics which had been essayed in 1890 from the Channel Islands against Sir George Tryon at Plymouth, and which, also, would endeavor in every possible way to thwart whatever designs might from time to time occur to the Red commanding officer. To Red's light craft were entrusted such duties as would naturally fall to the lot of cruisers, scouts and dispatch vessels in war-time. Blue's heavy craft were to do the work merely of guard-ships and depôt-ships.

Seeing that, at the time of writing, the official report of the umpires has not been made public, I am obliged to trust exclusively to my own observation for a knowledge of what occurred. This, according to my diary, as kept from day to day and as amplified from information obtained at the time from officers concerned, was briefly as follows:

Wednesday, July 22. The Red small craft left Milford Haven to scout in the Channel.

Thursday, July 23. Early this morning they returned, claiming to have taken or sunk in the offing eight Blue torpedo-boats which had been prowling about outside. At 6 a. m. the ironclads, having taken in their nets, weighed and proceeded to sea from Dale Roads. A few hours afterwards nine Blue torpedo-boats made a raid into Milford Haven, but found the quarry gone.

Friday, July 24. This morning the Red Squadron appeared off Kingstown, and for four hours fired at the Belle-isle, which lay behind the pier with her guns masked by it, and which was then claimed as destroyed. The Red Squadron thereupon headed for Belfast.

Saturday, July 25. At 12.20 a. m., while the Red Squadron was still on its way under easy steam to Belfast, torpedo-boat No. 74 approached the Northampton, which was last in the line, and discharged a Whitehead, which struck the ironclad on the port quarter, but not until the boat had been under fire for at least four minutes. The umpires, who were appealed to by telegraph from both sides, adjudged the boat to have been out of action when she launched her torpedo. Arrived in Belfast Lough, the squadron found that the Hecla had laid down extensive mine-fields to protect herself. It was deemed inadvisable to risk the ships or waste time, and the squadron withdrew to Luce Bay, Wigtonshire, where it anchored at 2 p. m., got out its nets, and sent out its small craft to scout.

Sunday, July 26. At 2.15 a. m. torpedo-boats Nos. 42, 25 and 55 attacked, having crept under the land and so got inside the Red Squadron. No. 42 discharged a Whitehead, which missed the Hotspur, the center ship of the line, and, almost spent, ran gently into the Northampton's nets. At 3 a. m. No. 83 attacked, discharging at the Northampton a torpedo which failed to run.

Monday, July 27. At 12.43 a. m. torpedo-boat No. 25 entered the bay, under the land, rounded the Northampton's bow, came down on the starboard or land side, and discharged a Whitehead which failed to run. At daybreak nets were taken in, and at 8 a. m. the squadron steamed south.

Tuesday, July 28. While the squadron was at sea in the early morning two torpedo-boats came up astern. One did not press the attack, but withdrew on being fired at. The other approached and attempted to torpedo the rearmost ship on the port quarter, but the Whiteheads failed to run. At 2.45 a. m. a third boat came up astern, but withdrew on being fired at. At 9 a. m. Wicklow was reached, and by 1 p. m. the Traveller, which was found there, had been put out of action by the guns of the ironclads. The squadron then steamed to Milford Haven.

Wednesday, July 29. At 9.30 a. m. the Red Squadron anchored in Milford Haven, in its former anchorage, and got out its nets, while the small craft scouted in the offing.

Thursday, July 30. At 1.30 a. m. two torpedo-boats attacked the Shannon and Hotspur, but did not strike them and were put out of action. At 3 a. m. a third boat, No. 45, attacked the Northampton from astern and fired a torpedo, which, however, did not touch the nets. At 12 a. m. hostilities ceased.

The usual formation, while the Red Squadron was at sea, was with the three armored ships in column of line ahead, and with the light craft disposed around them, ahead, astern and on the beams, at distances of about 10 cables. The important and suggestive points to be borne in mind in connection with the operations are: (*a*) that none of the torpedo attacks were completely successful; (*b*) that, out of eight torpedoes discharged, three failed to run; three ran but failed to hit anything; one ran, missed its aim and hit something else, but did not hit it until the impulsive force had been expended; and only one ran, hit what it intended to hit, and (save that the boat which discharged it was already theoretically out of action) did its appointed work; (*c*) that every torpedo attack that was made against the ships while they were under steam was made from astern; and (*d*) that all the attacks made against ships at anchor were altogether fruitless, while the only one which met with even comparative success was made at sea. All the attacks were, by the way, made during the night.

I must cite two other examples of the use or abuse of torpedoes and torpedo-boats. I shall then have referred to all the most important of my "leading cases," and shall be free to point out the lessons which it seems to me are to be derived from them and from others.

I have heard it said over and over again that the sinking of the Blanco Encalada teaches no lessons, and I have as often disagreed. It is, I submit, in some respects the most significant leading case we have. I was not upon the Chilian coast at the time, but I have before me the official dispatches from both sides, and, better still, an account which has been kindly prepared for me by my friend Capt. St. Clair, late of H. British M. Ship Champion, which was upon the coast. This account includes the substance of a report that was rendered by the Champion's gunnery lieutenant, Mr. R. B. Colmore, who, with the aid of divers, thoroughly examined the Blanco Encalada two days after she was sunk.

The Blanco Encalada arrived in Caldera Bay on April 22d with several transports in company, and at once landed a force which left by railway to take possession of Copiapo. Captain Goñi, of the Blanco, commanded the force, and, after Copiapo had been occupied, returned to Caldera, boarding his own ship at about 1.30 a. m. on the morning of the 23d. In his absence no fears of any attack were entertained and no precautions had been taken.

The ship was lying at a buoy in the southern part of the bay, with steam ready for moving the engines, and with the ordinary guard of seven men on watch. The armament of rapid-firing and machine guns had been reduced to admit of arming the transports, and at the time the ship had three 6-pr. R. F. Hotchkiss guns, disposed one on each side of the forecastle and one on the poop; four 1 inch Nordenfelts, disposed one on each side of the fore-bridge, one on the after-bridge, and one on the starboard side of the poop; one Hotchkiss R. C. in the top; and two .45-inch machine guns. Her original complement had been 300 well-trained men, but of these only 80 remained on board, the rest having been drafted to other vessels or landed with the Naval Brigade, and their places having been taken by raw recruits who had small knowledge of their duties, or even of a ship.

The Almirante Lynch and Almirante Condell were commanded by Captains Moraga and Fuentes, both of whom had received torpedo training at the Torpedo School in Valparaiso under Captain Santa Cruz; and they had the services of an experienced French torpedo artificer who had recently arrived from Europe to repair and adjust torpedoes for the Chilian government. The armament of each consisted of three 14-pr. R. F. Hotchkiss guns, disposed two on the forecastle *en échelon* and one on the poop; four 3-pr. R. F. Hotchkiss guns, disposed two on the poop and one on each beam or sponsons; and five torpedo-tubes, disposed one ahead and two on each beam. The torpedo-gun-vessels left Valparaiso on the 18th, and spent part of the 18th and the whole of the 19th and 20th in Quinteros Bay, and started northward again on the 21st, arriving off Huasco at two o'clock on the afternoon of the 22d. There they remained until after 5 p. m., probably, as would appear from Captain Moraga's report, until about 6 p. m. Quinteros is, roughly speaking, 400, and Huasco 100, miles from Caldera; so that, if up to 6 p. m. on the evening of the 22d the Congressionalists at Caldera had been informed of the whereabouts of their enemies, they would have known them to be 100 miles away. There seems to be no reason for supposing that they had any knowledge that the foe had come north from Valparaiso at all.

Caldera Bay opens to the northwest. Instead of entering round the southern promontory on which stands the lighthouse, the attacking force appears to have kept away until well beyond the northern promontory, and to have then turned and entered on that side. Says Captain Moraga:

"Shortly before 4 o'clock in the morning (of the 23d) I entered Caldera Bay. So far as the moonlight permitted, I reconnoitred the position of the revolutionary vessels from the bridge. In the meantime the Lynch followed in my wake at a distance of about 50 meters. When I had discovered the positions of the vessels I retired at half-speed directly for the Blanco or Cochrane, for at that moment I did not know which of the two ships was before me. Behind the after-part of the ironclad I distinguished another vessel, which from her outline I took to be the Huascar. At a distance of about 100 meters I discharged a bow torpedo, which missed and, almost grazing the stern of the ironclad, probably struck the ship which lay close to her. Immediately after this first shot I turned to starboard, and at about 60 meters fired one of the port torpedoes, which must have struck the forward part of the ship attacked. Almost simultaneously I ordered Lieutenant Rivera to let go the second torpedo on the same side. Between the second and third discharges the ironclad opened fire upon my ship with great quickness and spirit from mitrailleuses, rapid-firing guns and small-arms. After my ship had discharged her first torpedo I ordered full speed ahead. The fire of the ironclad remained concentrated on the senior officer's ship, and they did not notice that the Lynch, which had followed the motions of the Condell, placed herself at very short range and fired her bow torpedo, which missed. Turning to starboard, the Lynch discharged her second torpedo, which struck the Blanco somewhere amidships. Two minutes later the revolutionary ship sank. From the discharge of the Condell's first torpedo to the discharge of the Lynch's second, about seven minutes elapsed."

The account obtained by the Champion's officers from Captain Goñi and other survivors is as follows:

"The morning was dull and cloudy, the moon at intervals being completely obscured. At about 4 a. m. the torpedo-vessels were sighted by the lookout men at a distance of about 2000 yards. The alarm was at once given, but some delay took place in getting the people to their quarters, owing to the bugler mistaking the orders and sounding the ordinary reveille instead of the call for action. By this time the torpedo-vessels had approached within 500 yards on the starboard bow, and fire was opened on them from R. F. and machine guns. This was at once returned, the Condell at the same time discharging her bow torpedo, which passed ahead of the ironclad and, running on shore, exploded there. The vessels then

appeared to stop their engines. Orders were given on board the ironclad to slip the cable and go ahead with the port engine and astern with the starboard, but these orders do not seem to have been carried out. The Lynch then went full speed ahead, passing along the starboard beam and discharging both tubes at a distance of about 100 yards. One torpedo struck the Blanco and exploded. That vessel slowly heeled over and sank in less than five minutes. She first fired one of her heavy guns, but the shell passed over the Lynch without damaging her, and the latter passing under the Blanco's stern, discharged her bow torpedo at the transport Biobio, which lay inside, but without effect. The torpedo is said to have passed underneath the transport. The torpedo-vessels then steamed out of the bay, apparently uninjured."

The discrepancies between the two accounts are remarkable, but perhaps not greater than should, in the circumstances, be looked for. Nor do they affect the conclusions, which are, that the Blanco Encalada was surprised and destroyed, and that her assailants got away from her practically scot-free. Torpedo practice and gun-fire seem to have been alike execrable.

My last leading case is that of the attack on the armed transport Aconcagua. This is what Captain Moraga, of the Condell, has to say about it:

"As we drew off from Caldera we fell in with the transport Aconcagua, which was coming from the southward as if to enter the bay. As soon as she recognized us she endeavored to get away, turning to seaward and at the same time opening fire on us. When the revolutionary transport perceived that, on account of our superior speed, retreat was hopeless, she again headed for Caldera, possibly in expectation of there sighting her consorts and being assisted by them. She was at once engaged by the two torpedo-vessels in an action which lasted for an hour and a half. During this period the fire of the Lynch and Condell silenced that of the Aconcagua and forced that ship to stop her engines. She did not strike, for she fought without her flag. At the crisis of the action there appeared on the horizon smoke, which I imagined to proceed from the Esmeralda; and, in addition, several tubes in one of my port-boilers exploded and obliged the engineers for a few moments to leave their employment in that compartment. In consequence of these occurrences I headed to the southward and ordered the Lynch to permit our prey to depart. Soon afterwards I discovered that the vessel which had been sighted

was the ironclad Warspite of the English Navy. She seemed desirous of entering the harbor. The Aconcagua took advantage of the situation to head with all speed for Caldera and to place herself under the protection of the forts."

The official account of Captain Merino Jarpa, of the Aconcagua, puts a different complexion upon the action. It runs:

"At seven o'clock on the morning of the 23d of April it was reported to me from forward that the torpedo-vessels Lynch and Condell had been sighted off Morro Copiapo at a distance of about 7000 meters (about 4½ miles). I at once ordered the vessel to be headed in that direction, caused 'clear ship' to be sounded, and increased my speed. When I was about 4000 meters from them I opened fire from my rapid-firing guns. This was immediately returned by both vessels with great rapidity and promptness. So incessant was the discharge that it resembled that of small-arms rather than that of guns. At first they separated, as if to place us between two fires, but they soon altered their intentions, possibly because the manœuvre would have enabled me to use the guns on both broadsides. Both put themselves on our port hand. At this time one of them was struck by a shell and emitted such quantities of smoke and steam that for a period of two minutes she was completely invisible to us. Her speed, from this moment, sensibly diminished, and she fell away on the Aconcagua's port quarter, while the other craft kept parallel with us at a distance of from 1500 to 2000 meters. As this position did not permit me to use all my guns, I turned and headed the Aconcagua for the latter ship, and so was able to bring two of my 13-cm. (5.1″) guns into action. Upon this the torpedo-vessel increased her speed and withdrew, keeping away to seaward. The action began at seven and ended at twenty minutes past eight in the morning. During that time we fired without intermission 197 rounds, including 7 from the 13-cm. guns. The rest were from the rapid-firing guns, with a few from the Hotchkiss mitrailleuse. The Aconcagua's speed throughout the action was 11 knots. Out of more than 400 projectiles which the enemy fired from his rapid-firing guns eight only struck this ship, and these hit the woodwork above the waterline and did but little damage to the vessel and her crew. We had four slightly wounded. . . The action confirms the opinion that torpedo-vessels are useful only for unexpected attack. The view that they are worth nothing as fighting craft will perhaps be shared by the naval officers of the Dictator when they

reflect that during a ninety minutes' hot conflict they could gain absolutely no advantage over a simple merchant-steamer whose classification as a man-of-war is based solely upon the fact that she happens now to carry a few guns of small calibre. From this it results that torpedo-vessels are lost from the moment when they encounter a real man-of-war, if only she can bring them to action."

Captain Jarpa's conclusion that torpedo-vessels are useful only for unexpected attack seems to me to be fairly supported by all the examples which I have cited, and by the majority of the other examples which I might cite. The successful attacks on the Housatonic and the Albemarle, during the war of Secession, were surprises; the Russian torpedo-attack off Batoum on the night of May 12th-13th, 1877, was a surprise, and, but for an accident, would have been successful; the successful attack, a fortnight later, on the monitor Seifi, off Matchin, was a surprise. On the other hand, the exceedingly gallant daylight attacks of June 20th and 23d, 1877, off Rustchuk and Nicopolis respectively, were costly failures. In the same year the Huascar, attacked with a Whitehead by the Shah, evaded the projectile by accidentally or intentionally altering course; and in 1885 the Polyphemus, during the Bantry Bay operations, easily escaped several Whiteheads which were aimed at her, she being able to see them, and having sufficient speed and turning-power to outmanœuvre them. Indeed, I can think of no case in which, either in peace or in war, a torpedo-attack, unless made in darkness or as a complete surprise, has attained its object, or would, but for accidental circumstances, have attained those objects.

Secrecy and suddenness, then, are desiderata of prime importance for the success of a torpedo-attack. Equally important are organization and training. The descent upon the fleet at Plymouth was made with sufficient secrecy and suddenness; but neither the organization of the flotilla nor the training of the ship's companies engaged was what it should have been. An officer who took part in the affair lamented to me that Lieutenant Sturdee's division of six boats was too large to admit of being properly kept in hand by a single commander, and another officer informed me that many of the lieutenants in command of boats had gone on board without proper instruments for the navigation of their craft in case of the separation of the flotilla; that the engine-room complements were not familiar with the machinery, and that the discharge of the torpedoes took place in some cases with undue haste and flurry.

These were the naturally resultant faults of incomplete organization and training. Similar causes led, no doubt, to the large number of failures to run during the British manœuvres of 1891, and to the numerous misses and failures of the Chilian war. One has heard of torpedoes having been fired before they have been tested for flotability, and even before they have been charged with air; and I myself have seen a torpedo picked up with its water-tripper jammed in such a way that it could not possibly act. Accidents, oversights and follies may always occur in connection with operations like those which are now under consideration, but system will reduce to a minimum the liability to any of these, and I shall devote the rest of this paper to the advocacy of the system of peace organization, training, and war-tactics which appears to be logically suggested by the experience of the past.

In order to be able, in war-time, to properly utilize torpedo-boats for a descent such as was made upon Plymouth in 1890, a naval power should, I am convinced, keep the greater part of its torpedo-flotilla perpetually in commission. I do not mean that each boat, where there are considerable numbers of boats, need be kept in full commission with, as in the British Navy, her lieutenant, one or two sub-lieutenants, and a gunner or boatswain on board. But the engine-room staff, since it can never know too much about the boilers and machinery, should be always attached to the craft, and should be given frequent opportunities of perfecting acquaintance with its delicacies and its peculiarities. The executive and navigating staffs require no such special and intimate knowledge. One torpedo-boat may be navigated and fought very much like another. Her idiosyncrasies—or, at least, her important ones—reside entirely in her boilers and machinery. While, therefore, each boat, if she is to be employed to the greatest advantage, must have an engine-room staff that is thoroughly accustomed to her, any competent navigator or any competent executive-officer would serve almost as well as one who had been born and bred on board. It would be enough, in ordinary peace-time, to place a trustworthy warrant-officer in charge, and to leave him there as second or third officer upon the full commissioning of the boat for manœuvres of war.

But a single boat would never, for any purposes, be regarded as an independent unit. What the unit in torpedo-warfare should be is still, in Europe, a matter of discussion. In infantry tactics the battalion is the unit; in artillery tactics it is the battery; in torpedo-

boat tactics it must be the division; but battalions and batteries are not in all armies of the same strength, nor even in particular armies are they always invariable; and the same is the case with torpedo-boat divisions. The German division, for example, consists of six first-class boats and a "division boat"—a vessel of three or four hundred tons' displacement, of great speed, and of characteristics generally resembling those of the "avisos-torpilleurs" of the French navy, or of the "torpedo-gun-vessels" of the British. In England the division has contained six, four, or three boats, with or without a torpedo-gun-vessel attached. In France, also, the constitution of the division varies, or has varied. Professional opinion now, however, seems to incline in most countries in the direction of the division of three boats, with, if possible, a larger craft to carry the divisional commander, to lead the navigation, to undertake the repair of small defects, to provide supplies of water, coal and stores, and in short to act, for brief periods, as a small *mere cigogne* to her consorts. Where three boats to the division are not advocated, two appear, save in Germany, to meet with more favor than four, and four with more favor than five or any greater number. British officers of experience, almost with one accord, advocate three, with a larger craft; and I shall confine myself to the consideration of the division as thus constituted; for I believe it to be far and away the best.

The peace "state" of such a division would include a full complement for the larger craft (which would be commanded by a lieutenant; with a lieutenant for navigating duties; a sub-lieutenant or ensign, a chief engineer, a surgeon, and subordinate officers under him), and reduced complements (consisting only of a warrant-officer and engine-room staff) for each of the three boats. The divisional commander would thus have at his disposal sufficient officers and men to enable him to keep his division in good order and training, and to continually exercise part of it along the coast in the neighborhood of his headquarters. But he should by no means be the sole director of its operations. An officer of a superior rank (a lieutenant-commander, commander or junior captain) should be appointed to a small cruiser or gun-vessel as inspecting officer, and should be empowered and required to visit all divisional headquarters unannounced, and, by day or by night, to mobilize the divisions, manning them up to full war complement from the ship's company of his own vessel, and then exercising them at manœuvres at full speed. If, for example, a division had its headquarters at Newport, R. I., an

inspecting officer arriving there unannounced by night would teach valuable experience to the command by mobilizing and dispatching it in all haste to Nantucket or to New Haven, Conn., and back. The celerity, ease and absence of mishaps with which the operation should be carried out would to a large extent measure the efficiency of the division for the kind of work to which it would be put in war-time.

And here I may fitly state some of the arguments in favor of adding a "division-boat" or torpedo-gun-vessel to each division. Every one who has had much experience at sea in torpedo-boats knows how very limited is the horizon from the low deck of so small a craft, and how difficult—especially in bad weather—is the navigation of her. A vessel with a mast of some kind, and with a proportionately wider horizon, can keep a far better lookout than any torpedo-boat, and so avoid dangers that the torpedo-boat may easily fail to discover until she is close upon them. Again, the larger vessel being roomier and steadier, can take observations and conduct navigation with much greater facility than the smaller one, and may, in fact, "make" the navigation for her consorts when they cannot readily make it for themselves. But this is by no means all. The inevitable delicacy of torpedo-boats renders them particularly liable to slight but not insignificant damage by collision and other accidents. A "division boat" can carry appliances for the remedy of innumerable small defects either in hull or in machinery. She can also tow a more seriously injured craft; render effective help to the crew of a foundering one; serve as hospital to her division; make a lee for the protection of her little consorts; shield them, until the critical moment, from the observation of a careless enemy; cover them with her guns, and render them a thousand small offices of value, besides inspiring them generally with confidence.

So numerous are the advantages attendant upon the presence of a division-boat with the division that, in my humble opinion, a division should as seldom as possible be employed without such a leader; but circumstances will in war-time of course occasionally arise to render impracticable the combined operation of a whole division as thus constituted. For example, there may be a scarcity of vessels. This cause would, for the present, stand in the way of the formation of regular divisions in the United States and in some other countries. And it might, in certain contingencies, stand in the way of the formation of regular divisions even in those countries which are

best provided both with torpedo-boats and with torpedo-gun-vessels; for it is easy to conceive that, in the event of hostilities between a very strong naval power and a comparatively weak one, the naval ports of the latter might be so carefully watched as to make it hopeless for a regular torpedo-flotilla to issue from them with any prospect of being able to deal a sudden blow. Single vessels might escape and take refuge temporarily along the coast until they saw their opportunity to strike, but they might be unable to arrange any combined attack and might be reduced to operating independently. This would deprive them of much of their value; and therefore I confidently anticipate that in the next war, wherever it may occur, means will be devised to facilitate the concentration and combined action of torpedo-boats in spite of any system of observation or actual blockade that may be established by the enemy.

Devices of this kind would not facilitate the co-operation of division-boats, save in countries which are exceptionally well provided with a network of canals of some depth; but they might, in all civilized countries, ensure the complete mobility of torpedo-boats not exceeding about fifty tons displacement.

Thus, supposing the United States to be at war with some country of superior naval power; supposing the United States to possess six torpedo-boats and no more; supposing all those boats to be lying at New York; and supposing New York harbor, with both the Narrows and Long Island Sound, to be closely sealed up by the largest and most efficient fleet that could be collected off the coast:—supposing all this, I say, it would be by no means difficult, if proper arrangements were made, to deal by means of the torpedo-boats a very staggering blow at the blockading fleet, and, moreover, to deal it from the least expected quarter, namely from seaward.

In 1887 experiments were made in France to test the transportability of torpedo-boats by railway. The first-class torpedo-boat No. 71 was sent overland from Toulon to Cherbourg in August of that year. The special train which carried it consisted of three carriages, two freight-cars for the armament, two more freight-cars for the stores and gear, and a series of specially constructed trucks for the boat itself. The boat measures 108 feet long, 10 feet 8 inches broad and 9 feet deep, and at the time of transit weighed 38 tons. It reached Cherbourg in four days, but it did not travel by night; and so it may be assumed that had promptness been necessary it could have covered the distance of about 700 miles in forty-eight hours or

less. The cost of the single experiment was, at the time, stated to be but 7000 dollars. In the total the expense of the specially built trucks was, of course, a very large item.

What could be done in France could be done with even greater facility in the United States or in England. In the case which I have imagined, the boats shut up in New York could, in a very short space of time, be transported say to Atlantic City, Cape May, New London, or Bristol, R. I., whence, having awaited a favorable chance, they might operate with deadly effect, and probably with small risk, upon the rear of the blockading fleet. The only special appliances that would be requisite would be the trucks, and at each end of the distance a short branch line of rails running from the existing track into the sea. The trucks could be built in three days; the branch lines could be laid in as many hours.

Probably no attack would have better prospects of success than one conducted in this way; for it might be made from any one of a hundred different quarters, and it would be obviously impossible for any fleet to watch all the practicable points from which the boats might be launched upon their mission. But the case which I have imagined is an extreme one. Effective blockades are growing every day more and more difficult. In August, 1888, I was with a squadron consisting of the British vessels Warspite, Iris, and Severn, which, without being observed, and with the greatest possible ease, escaped from Bantry Bay, in spite of the attempted blockade of the comparatively narrow-mouthed haven by seven battleships, seven cruisers, and six torpedo-boats. Save in the face of perfectly overwhelming outside force, a well-handled torpedo-flotilla, constituted either as a division or otherwise, should always be able to operate from a port like New York and to strike with the requisite suddenness. It would be from more open ports, or from ports with only one narrow entrance, that effective surprises, without railroad aid, would be really difficult.

And this leads me to the consideration of the three kinds of torpedo-boat attacks which seem to be permissible in the warfare of the future. These are:

A. Attacks from a base against an observing or blockading force that is close at hand.

B. Attacks against fleets or single ships cruising at sea at a distance.

C. Attacks against fleets or single ships at anchor close at hand or at a distance.

Attacks from a base against an observing or blockading force that is close at hand.—This is the form of attack in which the co-operation of the division-boat may, with the least disadvantage, be dispensed with. The approximate position and strength of the enemy are known. The superior horizon of the division-boat is therefore not required, neither is that craft likely to be so urgently needed to serve as a magazine, store-ship and refuge for the division as in the case of operations conducted from a distant base. I do not think that the number of vessels constituting the hostile force should influence the number of torpedo-boats to be employed. French tacticians have suggested that, in the attack, at least three boats should be devoted to each ironclad; but I would not use more than three boats in any attack, whether against a single ironclad or against a whole squadron. A greater number cannot easily be controlled by a single directing intelligence upon the spot; and if I had at my disposal more boats than three, I would utilize them, not in any solitary onslaught, but in a succession of attacks by divisions of two or three boats operating from different quarters at times laid down beforehand by a superior authority on shore. An attack in numbers would inevitably lead to confusion, and probably to collision and damage; for this reason I would not allow even a division of three boats to attack simultaneously *en masse*. The whole secret of success in torpedo warfare must lie in the wide utilization of those moral effects which are produced upon nearly all men by the unexpected, the terrible and the vague; and in order to utilize these to the greatest advantage, my boats, as well as my divisions, should go into action successively. One would be naturally tempted to select for attack the leading or the rearmost ship of the enemy. To choose the center vessels of a column would be to expose the boats to a concentrated fire from several crafts. On the other hand, the leading and rearmost ships, realizing their relatively exposed position, would be apt to be keeping a better lookout and to be more prepared than the others. On the whole, therefore, I am inclined to think that the best procedure is to adopt such tactics by way of commencement as will disorganize the enemy's preconceived ideas, and to then act as prudence and the situation may have suggested.

And here I would say one serious word which applies to all torpedo-attacks. Every contingency must be arranged and provided for beforehand. When the undertaking has once been begun the time for alteration of schemes has passed away. In presence of an

enemy, torpedo-boats cannot signal to one another without danger of betraying themselves, and they must therefore be prepared to do without signaling. But this does not, of course, imply that a single cast-iron plan must be adopted and rigidly adhered to. Alterations may, without difficulty, be prearranged, and their adoption may be made to depend upon the condition of the sea, or of the light, or upon the motions of the foe. If signaling were permissible, the work would be easier; but it should not be forgotten that in the French manœuvres of 1891 Admiral Puech would not, on a certain critical occasion, have discovered the whereabouts of Admiral Dorlodot des Essarts had not the torpedo-boats of the latter's squadron been reduced to making night-signals indicative of their inability to keep the sea. Indeed, the slightest glimmer from a lantern, the striking of a match, or the weakest suspicion of flame above the top of a smokestack may so effectively render abortive all attempts at surprises that nothing of the kind must be permitted upon any pretence whatever.

A fleet engaged in blockading or watching a port may be disposed in any one of a hundred different ways, and is almost certain to be at night in a formation different from that which it maintains by day. But it would nearly always be possible to ascertain something of its habits. There will probably be an inshore squadron of light craft and cruisers, while outside will be the battleships and other heavy vessels. The quarry should of course be the heavy vessels; and the initial problem for the attack is how to avoid the cruisers. The problem solves itself if the idea of transporting the boats by railway to some unsuspected and unwatched base be made use of. If that project be impracticable, the boats must feel their way out as best they can; but those boats which are to immediately co-operate must at all hazards keep together until they have passed the inshore squadron. I mean that if only one division be employed it must not, on any excuse, separate until it is quite certain that the whole of it has got through and is available for the prearranged work. If two or three divisions be employed, each may go out independently; but the second must not start until it knows that the first has escaped, nor must the third go until the second is safe; for just as boats No. 1, No. 2, and No. 3 of each division are dependent, No. 2 upon No. 1, and No. 3 upon No. 2, so are squadrons 1, 2 and 3 of the whole force. It will not be of great importance to Division No. 1 to know that Division No. 2 is out; but it will be of the highest importance to

Division No. 2 to know that Division No. 1 is in a position to do its share towards preparing the way for No. 2's attack.

If the outgoing vessels be fired upon, they should not return the fire, or even hesitate in their attempt, so long as there remains the remotest possibility that they are not clearly seen and recognized. Experience shows that cruisers often fire at things which exist only in the imagination of some excitable man. I well recollect that in 1888, upon the occasion of the escape from Bantry Bay, there was a great deal of firing from the blockading force, and that we all believed that we had been observed. It appeared afterwards, however, that we had not been seen at all, and that the firing had been directed either at an imaginary target or at some of our consorts which, though not trying to escape, were making a diversion in our favor. Nor need the outgoing boats necessarily lose heart if the search-lights of their opponents be flashed right upon them. In 1888 a search-light from the Hotspur was flashed along the whole length of the escaping Severn at a distance of not more than 2 or 3 cables (for we could distinctly see the people around the projector), yet by some chance the Severn was not discovered. But of course, should there be no doubt that the attempt has been fully detected, there should be a retreat. An axiom of torpedo warfare is that, save perhaps where mere picket-boats and launches are her opponents, the torpedo-boat must avoid being attacked and being provoked to fire until she is endeavoring to use her torpedoes. And another axiom is that she must not employ torpedoes as weapons of defense against casual foes, but must reserve them for employment as weapons of offense against the main enemy. Her proper defence is evasion, and if forced to it, flight.

In addition to the position and formation of the enemy, the wind deserves the attentive consideration of the attacking commander. Approach from leeward, especially when the wind is on the beam of the ships to be attacked, seems, upon the whole, to hold out the greatest promise of success; for the smoke of the ships' guns when they open, while sufficient to obscure the boats from the ships, will not be sufficient to obscure the ships from the boats. If there be no wind, an attack is certainly best made from seaward, firstly because that is the quarter which is regarded with least suspicion; and secondly, because the boat, having attacked and discharged her torpedoes, need not lose time and incur risk while turning under fire, but may run straight past the enemy back to port. But special circum-

stances must regulate the interpretation of all general rules. Where the coast is bold, and the depth of water has invited the enemy to cruise close in, it may be found wise to make the attack from under cover of the shadows of the land. In such shadows, both when there is no moon and when the moon is low down over the land, a torpedo-boat can only with the utmost difficulty be detected. It was by taking advantage of the land-shadows that the boats of the Blue Squadron were able to approach the Red Squadron at anchor in Luce Bay on the morning of July 26 during the British manœuvres of 1891. I was watching for them with an excellent night-glass, but, while in the shadow, they were absolutely invisible, although they were less than half a mile away, and although the night was by no means a very dark one. I do not desire to advocate the making of the attack from any particular quarter, so much as to dwell upon the necessity for well organizing it beforehand, and upon the advisability of prefacing the real attack with one or two feints from a different direction.

On the eve of an attack the boats to be employed should test all their torpedoes both as to immersion and as to the working of the machinery. The weapons should then be freshly charged, and, finally, everything should be formally and severely inspected by a responsible and specially qualified executive-officer accompanied by an engineer-assistant. The inspection should take cognizance of officers, men, armament, engines, charts, instruments, etc., down to the smallest detail, and, the general plan of attack having been decided upon, all possible contingencies must be provided for. The main object to be attained is that, at the specified hour for the commencement of the action, all boats shall be in their prearranged position, and that each commander shall know what every other is going to do and when he is going to do it, and also what he himself has to do, and at what moment. All is to tend to the due carrying out of successive single concerted feints and attacks which have been prearranged and set down with the conciseness and accuracy of the entries in a rail-road time-bill.

The chief cautions to be observed, so far as experience causes them to occur to me, are, that boats should never expose themselves longer than is absolutely necessary, and should, as quickly as possible, withdraw out of sight and rapidly shift position so as to appear next time from a new quarter. Haste and excitement must be studiously repressed by the officers, who should themselves discharge

the torpedoes from distances never exceeding one cable: in returning to port after action boats must throw off the rule of secrecy and in some unmistakable manner announce their approach to their friends, signaling also whether or not they are pursued. If this precaution be not taken the returning boats will certainly be fired upon. Sir George Tryon's well-known maxim is: "In war-time, if you see a doubtful torpedo-boat, fire at her without waiting to ask questions"; and, in offering this advice, the gallant admiral is fully justified by all that has been seen of torpedo-boat work in the past. I think, however, that if returning boats made use of some very conspicuous rocket-signal, each boat having her own for that particular night only, no risk would be run by not firing at her. On the other hand, if there be the slightest doubt about the craft, she must be attacked as she comes in. Wherever it may be feasible, I should advise that boats do not return to port until daylight, and, in the meantime, take refuge in some unwatched cove or lie to where they are out of danger. It would indeed be a misfortune if boats, after having done good work outside, should come back to be sunk by their friends. But the risk is a very real one. Every recent series of manœuvres in England, France and Germany have exemplified it.

Attacks against fleets or single ships cruising at sea at a distance. In this kind of attack the division-boats may play an exceedingly important part. They can save their division from much useless wear-and-tear and exhaustion at sea, and can enable them to go fresh into action. The torpedo-boats themselves are, as has been said, not fit to attempt to keep the sea. If they do so they do it at the expense of the nerve and physique of their officers and men. But the division-boats can keep the sea without danger of this kind; and it is therefore an unfair test of the capabilities of a torpedo-flotilla to send it, as was done during the British manœuvres of 1891, to worry and attack a seagoing fleet, and to deprive it of the co-operation of torpedo-gun-vessels. It is equivalent to sending a battleship fleet to sea without cruisers.

When one talks of torpedo-attacks against ships at sea at a distance, one speaks, of course, relatively. No one dreams of attacking in this way a fleet in mid-Atlantic, or even five hundred miles from shore. But a fleet operating, for example, in the Adriatic, in the English Channel, in the Irish Sea, among the West India Islands, or within, say, 150 miles of any coast-line, would be susceptible of attack by an enemy possessed of a shore-base within range. That

base need not be one prepared beforehand. Only a safe and unobtrusive haven for torpedo-boats is needed, and any retired little bay with a sufficiency of water and not too difficult an entrance will serve admirably.

From the base, having first seen her smaller consorts snugly anchored in it, the division-boat issues. If there be two division-boats so much the better. They go forth alone, and at 18 or 19 knots speed. They scour the seas in search of the enemy. Having found him, they follow him a little so as to discover, if possible, his intentions, and then send or take back information to the base. If they be near a friendly coast, they telegraph the information from the next point and order a rendezvous. If they cannot telegraph, one of them must go back with the news; but as the division-boat should be able to cover about 150 miles in eight hours, and as a fleet, unless pressed, does not do much more than half the distance in the same period, the loss of time, though regrettable, is not particularly serious. Upon receiving the information the torpedo-boats make the best of their way to the rendezvous. This brings them somewhere in the neighborhood of the fleet. They pick up their division-boat and follow the quarry, taking care, however, to keep well away from his cruisers by daylight. At night an attack, arranged very much as in the case of an attack upon a blockading fleet, is made, the division-boats covering their divisions as much as possible, and then standing by either to attack meddlesome cruisers or to render help to their divisions in case of need. I do not think that they should approach ironclads unnecessarily, for they are comparatively large targets, and big shells bursting in them may easily be fatal; but I think that they may advantageously interfere to harass and take off the attention of the enemy's scouts; and if one of the latter should be a little rash or unwary, there may be an opportunity of torpedoing her. Before any attack, a rendezvous for each division should of course be arranged. If there be more than one division, the two points of rendezvous should be well out of sight, but not too far distant one from the other. Once more a series of successive single concerted feints and attacks, directed according to plans as prearranged, seems to promise the best chance of success. I desire, however, to call attention to some of the relative advantages and disadvantages of attacks from ahead and attacks from astern upon a fleet under steam; since a consideration of these may influence a divisional commander in his choice of the quarter whence he will attack most seriously.

The economical steaming speed for most large ships is about ten knots. This is about the speed at which a squadron would be likely to cruise in war-time, unless it were engaged upon some pressing duty; and it is a speed which is roughly equal to 17 feet a second. The attacking speed of torpedo-boats ought to be at least 18 knots. This is a speed equal to over 30 feet a second. On a moderately dark night a torpedo-boat approaching is not much exposed to detection by the lookouts in a battleship so long as she is at a greater distance than 2000 yards. She may, of course, be prevented by cruisers and light craft from approaching even so near as that. But for the purpose in hand I will assume that she is not. The range at which, with reasonably favorable prospects, she may discharge her torpedoes at night at a moving target does not probably exceed 150 yards. It becomes, therefore, in the highest degree important to her to traverse in as brief a period as possible what I may call the Helpless Zone—the zone, I mean, in which, although she may be discovered and fired at, she cannot effectively attack in return. She will naturally traverse it most quickly if she approach from ahead on the line of the enemy's course.

In the case of vessels having the speed given above, viz. 17 feet per second for the ship, and 30 feet per second for the torpedo-boat, the times occupied by the latter in traversing the Helpless Zone of 1850 yards (5550 feet) are:

If attacking from right astern	7 mins.	7 secs.
If attacking from right ahead	1 min.	58 "
Balance in favor of attack from ahead .	5 mins.	9 secs.

Seeing that, so long as she remains in the Helpless Zone, a torpedo-boat is liable to be struck and damaged or sunk, without being able to do the work upon which she is employed, this possible reduction of the period of exposure deserves serious attention. What it means may be illustrated by a moment's consideration of the enormous number of projectiles which a modern vessel can launch at an opponent in the space of a single minute of time. Many a battleship of recent construction can bring to bear right ahead or right astern two heavy guns, six rapid-firing guns, and six machine-guns or revolving cannon. Leaving the heavy guns aside, the rapid-firing guns could, in a minute, fire eight and the machine-guns 200 projectiles apiece. This, from such a battleship as I have in my

mind, would give a total of 1240 projectiles of all sorts per minute. Surely it cannot be a matter of indifference to the commander of a torpedo-boat whether he run the gauntlet of about 2470 projectiles or of about 8750. Nor is this all. The slower the approach of the boat the greater will be the accuracy of the ship's fire; and the more prolonged the exposure, the more will that accuracy of fire increase. In addition—and this is very important—a torpedo discharged from the boat coming down ahead will near the ship much more rapidly than one discharged from a boat following astern, and will afford proportionately less opportunity to the enemy to outmanœuvre it. But although I would attract attention to this, I do not wish to be understood to imply that any torpedo ought to be discharged from right ahead or right astern. A torpedo discharged from right astern is liable to be deflected by the wash from the ship's propellers, and has, moreover, but a small target; and a torpedo discharged from right ahead has not only a still smaller target, but has also to contend with the ship's bow-wave, which is almost certain to deflect the weapon harmlessly astern. The proper position from which to discharge the torpedo from a boat coming from ahead seems to me to be broad on the ship's bow; and from one coming from astern, broad on the ship's beam. In each I would prefer to use broadside rather than bow-tubes; for bow-tubes, when boats are running at high speed, often act most unsatisfactorily. Many authorities advocate that an effort should be made to hit the enemy in the neighborhood of his propellers and rudder; but experience seems to show that, if you can fairly explode your torpedo anywhere against his side, you will do him all the damage that is necessary; and undoubtedly, if you aim at him amidships, you are less likely to miss him than if you aim at his counter. If you succeed in disabling him in any way, his next astern may complete your work by running him down in the confusion.

I have dwelt somewhat upon this question of the direction of the main attack because, although it is quite obvious that, at least in some respects, the attack from ahead is much less risky than the attack from astern, nearly all the attacks which I have seen made during manœuvres upon ships under way have, strange to say, been executed by boats coming up from astern. This attack will always, I suspect, be the favorite one in peace manœuvres, because for various reasons it is in peace-time the easier to attempt. It may also be the fact that vessels habitually keep a worse lookout astern than ahead.

But I do not think it will be the favorite mode in actual war; for it bids fair to be too costly in men and material, owing to the relatively long exposure in the Helpless Zone. The attack from ahead against ships under way was not attempted at all during the British manœuvres of 1891. Two torpedoes only were aimed at ships under way, and both of these were discharged from boats approaching from astern; and all the threatened attacks came from the same quarter.

How to get safely out of action will be almost as difficult a problem as how to get safely in; but nothing more generally wise can be counseled than for the boat which has already swerved a point or two, in order to bring herself on to the bow or quarter of her opponent, to complete a turn of eight points, if there be a second ship in the line, and to get away as fast as she can, showing her stern to the enemy's broadside, and so affording as small a mark as possible. If, before doing so, she can discharge a second torpedo, so much the better; but when withdrawing she must not lose sight of the probability that she will encounter a cruiser or be pursued by one, and therefore, as soon as she is out of the zone of immediate danger, she should sharply alter course for the quarter which seems to promise her the greatest security. It may appear inhuman to say so, but I cannot convince myself that a torpedo-boat, having sunk her enemy, should stand by to assist the survivors. Her crew is obviously too small to resist an attempt made by numbers and desperation to seize her, and she has no accommodation for prisoners. When there is no second ship, the best course is for the torpedo-boat to maintain her original direction. Using the helm involves delay, no matter how handy the boat may be, and should, when practicable, be avoided. Not far away, the boat should be able to rejoin her division, and with it she should be comparatively safe.

Attacks against fleets or single ships at anchor close at hand or at a distance.—I regard this as the least promising mode of attacking ironclads by means of torpedo-boats, for all modern ironclads have, or may have, torpedo-nets; and vessels properly commanded and possessed of nets would not fail to get them out immediately after anchoring in war-time. It is true that Captain A. K. Wilson, of the British Navy, has invented a species of shears which, fitted to the head of the torpedo, will enable it, provided all goes favorably, to cut through some existing nets; yet it is equally true that the invention, though ingenious, has little practical value, and that nets strong enough to defeat it could be easily carried, even if it were all that it

is intended to be. But certain vessels do not, and are not likely to, carry nets; and these, especially if they can be thoroughly surprised, may be attacked at anchor with good results. It may also be sometimes worth while to descend upon battleships immediately after they have anchored, in reasonable expectation of finding that they have not had time to get their nets out. As a rule, however, battleships will in war-time get their nets out and in very quickly. I know of ships in the Mediterranean which, when first commissioned, could not execute either manœuvre in less than three hours, but which can now do either in ten minutes. Commanders should, therefore, turn their attention to inducing hostile men-of-war at anchor with nets out to take their nets in, and to make them also, if possible, get under way. This they may sometimes do, particularly when the vessels are lying elsewhere than under forts, by obtaining the temporary co-operation of battleships of their own. Ships in unfortified havens will remain doggedly anchored when threatened by torpedo-boats, but not when threatened by craft of their own class, and when in deference to a feint by battleships they weigh, the torpedo-boats may dash in and find their opportunity. When an attack is made, the same considerations should guide it as should guide other attacks. Surprise, efficiency of men, machinery and weapons, and concerted action, are all-important factors in the success of the undertaking; and if the attack can be delivered from the most unexpected quarter —which in this case is the direction of the shore—it will have the best chance of doing well.

It is claimed for some of the most modern "marks" of the Whitehead torpedo that, if they hit a net fairly and squarely when running at full speed, they will penetrate it. This may be so. If they explode in contact with it, they will certainly demolish great part of it, no matter how it may be boomed out, and therefore it may occasionally be worth while to organize a torpedo-attack with a view to first destroying the nets and then the ships; but this seems to me to be a risky and precarious device, and one which should not be attempted where there is a possibility that other methods may, within a reasonable time, become practicable.

So much for those forms of attack which seem to be permissible.

The attacks which, in my humble view, are not permissible are attacks by daylight, and attacks during actions wherein two fleets are engaged. Concerning the almost absolute hopelessness of suc-

cess by daylight against any respectable enemy, I need, I think, say nothing; but it is necessary to say a word concerning attacks during actions wherein two fleets are engaged: firstly, because French tacticians notoriously believe them to be practicable and even advisable, and secondly, because at least one very capable British naval officer may be suspected of holding the same opinion.

The tactical unit of the French fleet consists to-day of a division commanded by a rear-admiral, and consisting of three ironclads, three cruisers, and three torpedo-boats. This unit was adopted a few years ago, and was deliberately readopted for the manœuvres of 1891. And, in his recently published book on "The Development of Navies," Captain A. Eardley Wilmot, of the British service, criticising the battle of Lissa, says:

"One thing is wanting to complete the valuable experience gained on that day and make it applicable to the present time. No locomotive torpedoes were used, this arm as a naval weapon not having been then introduced. Whether, after the line was broken and the ships were all mixed up together, it would not have been as dangerous to friend as to foe may well be questioned; but small vessels, specially armed in this way, would have had good opportunities of gliding in under cover of the smoke, and dealing deadly blows to partially disabled ships."

The objections to the use of torpedo-boats in fleet actions are two-fold. If they be used in fleet actions, they must, of course, accompany fleets to sea; and, whenever they have hitherto done so, the inconvenience of the plan has been abundantly apparent. They cannot, in bad weather, keep up with ten-knot battleships; they are perpetually in distress, and their crews get worn out and incapable of energetic action. Lieutenant Charles C. Rogers, U. S. Navy, in his summary of and comments on the naval manœuvres of 1890 (General Information Series No. 10, Office of Naval Intelligence), says of the French operations: "The battleships and cruisers behaved well at sea, but the torpedo and dispatch-vessels were a source of anxiety. Several times the battleships were obliged to take some of them in tow. The manœuvres seemed to prove that they have not sufficient endurance. Their very powerful and complicated engines are in small and light hulls; and in continued bad weather, which occurred during the later manœuvres, the personnel gave out constantly." And in his report on the French manœuvres of 1891 (*Marine Rundschau*, November, 1891) Kapitän-Lieutenant von Klein,

of the German Navy, remarks of the torpedo-boats: "These, which, with their superiority of speed, were intended to attack the enemy during the night, experienced trouble and discomfort in keeping up with the squadron at 10 knots. Those of A. Squadron, the ships of which steamed at 12 knots, were absolutely unable to preserve station, and had to be sent away to await better weather." This distinguished officer, in summarizing the lessons of the operations, suggests that they indicate that the proper functions of torpedo-boats are not understood in France, and that such craft should be entirely restricted to service as part of the mobile coast-defenses.

The other great objection to the employment of torpedo-boats in fleet actions has been hinted at by Captain Eardley Wilmot, and is, I am sure, a very real one. The boats would be as dangerous to friend as to foe. I have shown how, in 1890, No. 86's torpedo, intended for the Black Prince, apparently hit the Anson; and how No. 59's torpedo, intended for the Northumberland, hit No. 51; and how, in 1891, No. 42's torpedo, aimed at the Hotspur, struck the nets of the Northampton. I have shown, too, how, in both these British manœuvres, quite a number of torpedoes that had missed their mark were wandering about after almost every attack; how the same thing happened at the attack on the Blanco Encalada; and how probable it is that something similar will happen in the case of every future attack. What, then, would happen to two fleets of ironclads mixed up in a mêlée with two flotillas of torpedo-boats? The question seems to me to require no answer.

But there is a mission for small torpedo-boats, accompanying large ships to sea and acting from them as from a mobile base. The British torpedo depot-ship Vulcan—a comparative failure, I admit, yet the representative of a type which may easily be improved—carries six of Yarrow's 60-feet 16-knot boats, and these, dropped into a comparatively smooth sea within a reasonable distance of a hostile squadron, might, in certain circumstances, do very useful work. A land base is, however, always much superior to a floating one. It admits of larger and faster boats being employed; it gives the boats far better shelter; it involves much less wear-and-tear; and, in brief, it is above comparison with the other, which is at best a *pis aller*. A Vulcan, caught in daylight by a couple of fast ironclads, with her flotilla waiting around her to be hoisted inboard, would not be in an enviable position. A good land-base, containing an equal number of torpedo-boats, would be vastly safer, and could be easily rendered

so strong as to be perfectly secure, unless forces were landed to co-operate against it.

The limits prescribed for this paper will not permit me to offer any remarks on the subject of the handling of fleets and large ships in presence of torpedo-boats, but there remain some general considerations to which attention may be advantageously paid.

The French and Italian Governments have adopted the principle of establishing "nests," or small military harbors for torpedo-boats, around their coasts. This seems to be an unwise proceeding. A "nest," the existence of which is perfectly well known, can be guarded against and easily attacked. An impromptu "nest," on the other hand, can be quickly created almost anywhere on a deeply indented coast; may be quite as serviceable as a permanent one; and may, for a considerable period, exist in war-time unknown to the enemy. A permanent "nest," moreover, must be in some way protected by expensive works or by mines, while an impromptu "nest" may be, for a time at least, protected by the secrecy with which it has been formed. Stores and provisions for torpedo-boats can quickly and easily be sent to any point of a civilized country by rail, and it is almost as convenient for the boats to take them on board at one place as at another. Therefore I would strongly advocate impromptu, as opposed to permanent, torpedo-boat stations. The former conduce to mobility; the latter really tend to restrict it; and it is the mobility, within, say, a distance of 200 miles of your coast-line, of your torpedo-flotilla that, more than anything else, measures its utility. With a sufficient, efficient, and completely mobile torpedo-flotilla on its coast-line, a country should be able for a long time to keep any maritime enemy at a very respectful distance. Permanent stations are well enough in peace-time; in war-time, the first step would be to abandon them in favor of impromptu ones.

It has often been debated whether or not the search-light should be employed by torpedo-boats in the attack. My experience indicates that generally it should not. Silence, darkness, secrecy—all these are, as a rule, favorable to the boats, and they cannot be, as a rule, too carefully observed. But when an approaching torpedo-boat, which has been seen and fired at, discovers that the enemy has got her range and is doing her damage, she may, I am convinced, often save herself by boldly flashing her light full in the eyes of the gunners. I saw a case in 1891 in which, after the light had been so used, the range of the boat seemed to be entirely lost. The use of search-

lights, and especially of search-lights as against search-lights, is a subject which has not yet been sufficiently studied. As at present advised, I would prefer to dispense with them on ordinary occasions of defense as well as attack. The glare exercises a prejudicial and varying effect upon the eyesight, at the time as well as subsequently; and, while it may make valuable revelations, it may also make dangerous betrayals.

For the numerous failures of torpedoes to hit their target, and even to run at all, I think the human element is more to blame than the mechanical. Familiarity with the weapons on the part of those who have to use them will, as training improves, reduce these failures to a minimum; and the weapons themselves have now reached so great a degree of perfection that they leave very little to be desired. I do not mean that it is impossible to conceive a better automobile torpedo than the latest mark of Whitehead, but I do mean that the Whitehead seems to have very nearly exhausted such improvements as can be made in it; and that at present, although it has some inherent and inevitable defects, it is, upon the whole, better than any other torpedo. This is, I believe, so generally recognized that I am entitled, in dealing with the torpedo-warfare of the immediate future, to assume, as I have assumed throughout, that "torpedo" and "Whitehead" are almost interchangeable terms. Inventions, based upon principles which do not resemble the principles of Mr. Whitehead, are numerous, and several of them are very full of promise, and will some day, I doubt not, come to the front. But for the next year or two, should any naval war break out, the torpedo to be used will be the Whitehead chiefly, if not exclusively, or, of course, the Woolwich or Schwarzkopf, which is essentially the same thing.

The kind of warfare which torpedoes and torpedo-boats and vessels promise to introduce to us is not perhaps a warfare of the most heroic and chivalrous nature. Torpedo-vessels will not—and as the Aconcagua affair seems to show, cannot—meet other opponents in the open day and vanquish them with powder and shot in the old-fashioned style. It will be their function to steal up in the dark and deal a blow which some may deem rather the blow of the assassin than of the hero. But these considerations must not blind us to the immense value of these little craft when properly employed. War is to-day less than ever to be made with rose water and waged in kid gloves. Chivalry has less and less place in it. Utilitarianism in war, as in almost everything else, overrides

natural predilection. Nor is torpedo warfare an employment in itself unworthy of a patriot; for in it he may exhibit qualities of the very highest character, and only by devotion, steadfastness, carefulness, coolness and bravery, can he hope to gain the slightest success in it. If these few reflections of mine should help any patriot to the efficient defense of his fatherland, or if they should tend to convince any ambitious nation of the growing dangers of aggression, they will not have been set down in vain.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

CELLULOSE AND ITS APPLICATION AS A PROTECTION TO VESSELS.

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The idea of protecting vessels by means of a very light, self-obturating material was conceived by Admiral Pallu de la Barriere, an officer in the French navy. Being a learned man, as well as an officer of great merit, Pallu de la Barriere devoted a large portion of his life to studying the various methods of protecting those marvellous and formidable floating fortresses which constitute the basis of naval power in every great nation.

In some notes written some years ago the Admiral proclaimed the following, which, in his mind, embodied the main points of naval architecture:

"The battleship, in order to be properly qualified for naval warfare, ought not only to be unsinkable, but she should also preserve during the entire action her stability, her manœuvring power, and the height of her gun-platforms."

He then adds that "the unsinkable quality of ships varies in the merchant- and war-ships.

"A steamer belonging to the Messageries Maritimes was able, after a collision on the ocean, to continue her voyage from Japan to China after her prow had been torn away." This he designated "commercial unsinkability."

"An ironclad, struck by the ram of another battleship, was able, during 1½ hours, to float and reach a point where she intentionally stranded, although her two forward compartments were filled with water."

"This could not be called naval unsinkability. The vessel run into had lost her turning power; the form of her lines had been changed; her rudder was useless, and, therefore, in case of war, the ironclad would have been easy prey."

"The whole future of naval and military construction is contained in this one instance.

"When science has given a correct form to the idea of a vessel, that is to say, a buoyant body filled with a light substance which can be accepted as permanent for all space not used, to enable her to live, to progress and to fight, then it will have produced a battleship which will enter the fray with undisturbed firmness and without fear that the engines of destruction directed against her will be able to affect her in any way, besides being endowed with a species of artificial life sufficient to last throughout her role of destruction."

The realization of this problem (we might say of this dream) Pallu de la Barriere discovered in cellulose, the application of which has now entered into general practice.

There is a story connected with the discovery of the properties of cellulose; like nearly all other great discoveries, it was due to chance. A few years ago the crew of a French man-of-war were engaged in target practice not far from New Caledonia, when, to the general wonder, after each shot it was found impossible to locate the spot where the projectile had struck. They were all certain that the target had been hit, but no sooner did the projectile reach it than it seemed to disappear as if by magic. The commander at the time was the late Pallu de la Barriere, who at once started an investigation which led to the discovery that the shore which had been fired at was not an earthern target, as it was covered with the refuse vegetable matter from a factory where rope was made from cocoanut-fiber, where it had been accumulating for several years. The waves dashing on the shore had massed this fiber and dust into a hillock which the severe storms of the rainy season were unable to wash away.

This strange phenomenon attracted the attention of Captain Pallu de la Barriere, and he came to the conclusion that if such a substance could be applied to vessels of war, the ships protected by it could not sink, as their wounds would close of themselves and so prevent the inflow of water. Besides, this kind of protection would be very economical, as one had but to pick up waste material which was only in the way and of no value to the manufacturer; something that

he would gladly offer for nothing to save the cost of removing it himself. He had some tanks constructed which were filled with cellulose taken from that discovered on the beach. He then fired several shots into the cellulose, but the results did not come up to his expectations, as the marvellous effects which were observed when the great mass on the beach was fired at were not reproduced when only a few cubic meters were used.

The experiments were not carried further at this time, but Captain Pallu de la Barriere did not lose his faith in the value of this material, and after extensive experiments carried on by himself, he concluded that the processes employed by the manufacturers of goods from fibers destroyed in a great measure the very qualities which he sought. It was found necessary to sacrifice the fiber almost completely in order to give to the cellulose, by a special process, its maximum effect in small bulk.

I wish to add here that not only the processes, but the application of the cellulose itself to the protection of vessels is covered by letters patent all over the world.

As soon as he had perfected his invention, Captain Pallu de la Barriere laid it before the French Government. His statements were at first received with a general air of incredulity. It was the opinion that he was not in his right mind when he pretended to be able to protect men-of-war by means of this dust so light that a single breath would blow it away, just at a time when experiments had proven that the most formidable ironclads could be penetrated by chrome-steel projectiles.

However, experiments were ordered with the new material. For three years most exhaustive trials were carried on and the results carefully studied. The experiments were kept secret, but the results were so conclusive that the Government issued a decree that cellulose should be used on not only the vessels then under construction, but upon all the old cruisers and battleships.

Since this time, the greater number of the vessels built in France for foreign governments have also been protected by a belt of cellulose. It was in this way that Russia, Holland, Greece, Denmark, Norway, and even Japan have been induced to favor the use of cellulose in their vessels of war.

Hon. B. F. Tracy, the present Secretary of the Navy, wishing to provide the vessels built during his administration with all the improvements which modern science has brought about, desired to

have them protected by a belt of cellulose, there being no doubt as to its practical efficiency after the many successful experiments at Norfolk and elsewhere that are reported.

The manufacture of cellulose has now become a domesticated industry, since, in Philadelphia, a company has been organized which has built a factory which will be of sufficient capacity to supply the entire American Navy. The American cellulose will be in every respect identical with the French article, since the company has not only bought the French patents, but has had all the necessary machinery built there in the workshops of the inventor.

For a number of years past there has been an incessant conflict between the gun and the armor-plate. The thickness of the latter has grown while keeping pace with the ever-increasing penetrative power of the projectile. But this conflict must soon come to an end, as we well know that to go much beyond the thickness of armor now carried by the battleships of the world would be to add so greatly to their weights as to make them unwieldy.

When a projectile passes through the enormous thickness of metal which envelopes the vessel, she sinks the more rapidly the heavier the armor.

Endeavors have been made to localize the inrush of water by a system of cellular compartments, but considering the vast energy of the projectiles used now upon naval vessels, their explosion in the compartments would crush in their sides and cause the rivets to fly off by the hundred, letting vast quantities of water into these compartments which are depended upon to afford buoyancy and stability, —also changing the form of the lines, consequently modifying the action of the screw and rudder and so affecting the speed and manœuvring power.

The constructors recognizing this danger, have made many efforts to fill these compartments with some light material of a fixed weight which would keep out the great quantities of water by filling beforehand the large spaces into which the water might flow. They have tried in succession charcoal, sea-wrack, cork, poplar, and Italian brick or light pumice stone, also bamboo from Cochin China, and even tin boxes. In spite of their apparent great lightness, these substances represented in their totality a very considerable weight. And even if they did keep great quantities of water out of the compartments surrounding the shot-hole, they left the shot-hole itself wide open. It was necessary to try to close the hole under fire of the enemy, and after the leak was stopped to pump out the compartments.

An automatic closing of the shot-hole is the only thing that can efficiently protect a vessel during an engagement.

To attempt to close a hole in the side of an iron vessel while she is under fire is most hazardous, and as there are no efficient shot-plugs, to attempt such a thing would be almost useless. One must see a leak to obtain a proper idea of the violence with which the water rushes in, blinding the men attempting to stem it, dashing furiously aside every obstacle opposed to dam it, and generally demoralizing the crew. The automatic closing overcomes all these difficulties and dangers, since it acts spontaneously and without the aid of man.

It is true that the latest and most improved types of vessels are supplied with most powerful pumps, but at first the inflow of water might be so considerable that the pumps would not be able to handle it, while the forcing out of the water would lead to the expenditure of an enormous quantity of steam which would reduce the speed and interfere most seriously with the fighting efficiency of the vessel.

In other cases, as when small quantities of water enter into certain parts of the vessel, as, for example, above the slopes of the protective deck, while not sufficient to destroy the buoyancy of the vessel, the mobility of this water affects the stability of the vessel, her period and angle of rolling, and so directly the efficiency of the vessel as a gun-platform. This case is well put in a recent article published in the Naval Institute, which says:

"It is apparent that popular opinion regards the case only as one in which a small loss of buoyancy is the worst result, whereas the danger is likely to be critical, not from loss of buoyancy, but from the effect of the small quantity of water on the stability."

Cellulose is not a new substance, as it has been known for years to the botanist and the chemist. It exists in variable proportions in all plants, and in the tissues of certain animals of the lower orders.

The chemical formula representing this substance is $C_{12}H_{10}O_{10}$.

If you will examine a portion of a small branch of a young tree and subject it to successive washings with cold or hot water, alcohol, ether, weak alkaline solutions or diluted acids, so as to remove all soluble substances, you will have left a fibrous or *cellular* material which is in effect the skeleton of the plant,—hence the name of *cellulose*.

The husk of the cocoanut contains a large proportion of cellulose existing in the form of a species of pith which holds together the fibers which surround the nut.

This pith, however, is not chemically pure cellulose, as in its composition there are about 30 per cent of the salts of potassium and sodium (principally chloride of sodium or common salt), traces of manganese, a great deal of tannin and some salts of lead.

The chemical analysis of cellulose made from cocoanut husks is as follows:

Pure cellulose	83 parts.
Organic extracts	10 "
Ashes	7 "
Total	100 parts.

Far from being detrimental, the presence of these salts and the tannin has the great advantage of rendering the substance safe from decay and the attacks of insects.

The sole enemy of cellulose is the oxidation which takes place when iron and water are in contact with it.

All textile matters are in the same manner subject to destruction under similar conditions.

I wish to insist on this point because I wish you to realize the great importance of its bearing upon the practical use of cellulose. It is most essential that the shipbuilders, who must make use of this substance, shall not lose sight of the fact that cellulose, which contains within itself all the necessary elements for self-preservation, might be damaged by neglecting some simple precaution, such as coating the insides of the cofferdams or steel tanks built to hold it with suitable paint which will prevent the condensation or collection of moisture.

Independent of the above qualities, which are chemical in their nature, cellulose possesses physical characteristics which render it invaluable in shipbuilding, for either vessels of war or of the merchant marine.

It is extremely light, being only one-fourth the weight of cork (the substance usually cited when light substances are spoken of).

On account of its cellular structure it is highly compressible, and in consequence very elastic. Again, it possesses in common with other spongy bodies the property of absorbing water very rapidly by capillarity, and to swell up on account of this absorption.

It is well known that any kind of cellulose subjected to the action of nitric acid, or to a mixture of nitric and sulphuric acid, is transformed into a most inflammable and highly explosive substance,

which goes by the name of pyroxyl or gun-cotton, and serves as the base in the manufacture of celluloid. This will explain the confusion which seems to exist very often in the minds of people who are but little familiar with the science of chemistry, between cellulose and celluloid. I have often heard such people express their great amazement that any one should think of lining the sides of ships with such dangerous stuff which might blow them to pieces or cause them to burn like a piece of tinder.

The system of light protection by means of the meal of the cocoanut husk, as conceived by Admiral Pallu de la Barriere, has two distinctly different uses which are often confounded.

First, automatic obturation of shot-holes by a mixture of cellulose and fiber, placed in a loose state in the cofferdams or compartments and then packed. Secondly, to afford an obstruction to the entrance of water into the compartments, by filling them with blocks or briquettes of cellulose.

In the first case the cellulose is employed in the form of a belt of variable thickness, which amounts to 5 or 6 feet in the largest vessels. It exists then in a granulated or pulverized state, mixed with the fiber of the filamentary part of the husk of the cocoanut, in proportions determined by experience as being the best to produce a felt-like mass. The mixture which gives the best results in practice is formed of about 6 per cent of fiber, or more exactly, one part by weight of fiber to fourteen parts of cellulose. This mixture of cellulose and fiber is placed in the cofferdams of the vessels, and there it is compressed to such an extent that it occupies but one-half its original volume.

The effects produced by using this belt, where cellulose and fiber are proportioned according to experience, are, in fact, but the perfection of which wooden plugs furnish the primitive methods. There are in wood two essential parts, one composed of fibrous elements, which adhere to each other and which can produce a sort of felt; the other is composed of round atoms which do *not* adhere to each other and which are cellulose. We have taken from a fruit, whose nature possessed extraordinary qualities of lightness and imputrescibility, two essential parts—the fibrous portion, and a sort of amorphous cellulose—and have mixed them in a proportion to accelerate obturation and to maintain it.

When a projectile goes through a cofferdam filled with compressed cellulose, the elasticity and absorbing qualities of the substance come into play, for the material contains in itself two forces which

manifest and defend themselves while under the influence of the two causes of destruction, the projectile and the water, acting successively at short intervals on the buoyant body.

1. By the force of the projectile, the elasticity of the material (filaments and granules) naturally causes same to give way, making a passage, and then a reaction takes place by which the material assumes its original form, remaining constantly in contact with the projectile until it leaves the cofferdam, and avoiding any kind of a punching effect. The form of each particle of cellulose and its mobility in permitting the granules to slip over each other facilitate this instantaneous obturation, and the disposition of the fibers retains the cellulose in place. The material is not scattered because it gives way, and takes its original place because it is elastic. The density of the penetrated layers is not sensibly disturbed.

2. When the water coming in contact with the material attempts to follow the projectile on its way through the hole, the material develops still another important quality which, up to the present, had been latent. The swelling of each of these particles coming into contact with the water produces a very lively burrowing, the water now being the most active agent to prevent the water itself from passing through. Thus the projectile provokes the obturation and the water makes the wall solid.

Man does not interfere in any way by any supplementary compression, and the obturation may be said to be entirely automatic.

The cofferdam being of limited dimensions, the weight of the water absorbed may be neglected and cannot influence to any degree the speed of the vessel.

If the projectile happens to explode within the limits of the cofferdams, the greater number of the pieces of the shell will be embedded in the mass of cellulose, preventing in this way loss of life and the destruction which the pieces would cause in the structure of the ship. Hence we have here a substance which is not only obturating but ensures also the intactness of the bulkheads enclosing it. While the obturating value of cellulose is not questioned, many people have said that it would be blown out of the cofferdams by the explosion of shells within them. The statements I have made are, however, based upon actual experiments with 6-inch shells.

The other use of cellulose in the form of water-excluding briquettes which completes the system of light protection I shall now speak of. This is intended to answer quite a different purpose. Where it is

used the question of stopping holes need not be considered, but as I have stated before, it is a case of occupying in advance large spaces not utilized in the vessel which would become dangerous when filled with water. It is necessary to fill such empty spaces with a substance which possesses certain essential qualities. It must be very light so as not to add unnecessarily to the weight and so reduce the amount which can be carried in powder, shell, etc. It must be perfectly waterproof, so that it will not absorb water and constantly increase in weight. It must be secure against the various causes of destruction which might in time render it useless, such as insects or rot.

In this case, the qualities of absorption, of obturation, and of elasticity are not aimed at, but it is still to cellulose that we must turn, not in the loose and compressed state, but in the form of briquettes enveloped in a waterproof covering, because of all substances known it is the lightest which can be used for this purpose, and it is not subject to decay or the ravages of insects.

As an example of the comparative lightness of cork and cellulose I wish to cite the following:

The English battleship Inflexible has her cofferdams filled with 143 tons of cork and oakum; viz. 68 tons of cork of a density of 0.24, 75 tons of oakum of a density of 1.00.

If we should fill the same spaces with cellulose of a density of 0.12, the total weight would only be 43 tons, saving 100 tons out of 143 and at the same time securing much better protection.

If, then, we consider that briquettes of cellulose weigh about 8 pounds per cubic foot, while sea-water weighs 64 pounds, we can easily understand the importance of opposing the entrance of water by filling in advance the spaces with a substance eight times lighter than the water which would otherwise fill them.

Coal is often relied upon as a protection against gun-fire, but the extent to which it can be depended upon has led to many discussions among naval constructors, some of whom contend that it is to be depended upon as a protection: on the other hand, if it is to be used in the furnaces of the boilers, we are again confronted by the empty bunker open to the inflow of water.

I do not wish to enter into a discussion as to the merits of coal protection, but it strikes me that even admitting that the bunkers are full up to the moment of going into action and offer in this condition efficient protection, this protection is obtained at a great cost as to

weight, since coal is more than eleven times heavier than briquettes of cellulose.

Cellulose has been proved efficient during a number of years, and it is well established both by experience and practice that the vessel protected by it will continue to float, that is *to live*, even after being struck many times, and that she will preserve during an action her stability, her manœuvring power and the horizontality and height of her gun-platform, that is to say, her metacentric height.

Numerous experiments with different-sized projectiles have been made in France and other countries upon cofferdams filled with cellulose.

The detailed official reports of all these experiments would take up too much space in this article. The reader will be able to find them in a volume shortly to be published about cellulose.

I shall simply take as an example one of the recent experiments made in Norway at the Horten Navy Yard during the month of August, 1890, in order to give you an idea of the effect of shot upon cofferdams.

The target used at Horten was identical in form and dimensions with a cofferdam of the gunboat Viking, then under construction. It represented a belt of cellulose 8 feet high, 7 feet 9 inches long and 3 feet 4 inches thick. Three projectiles of 6 inches in diameter, weighing 68 pounds, were fired into the target. Two of these projectiles exploded within the limits of the cofferdam, and you could see a little smoke in each of the holes where the pieces came out. The shell which exploded in the cellulose ignited a small part of the cellulose directly in contact with the flame. A close examination showed that this fire was only on the surface; in spite of a strong breeze there was no flame, and the parts which were ignited could only be distinguished by small charred spots where the flame had passed.

To arrive at a proper understanding of the damage which might be caused by an accident of this nature, the cellulose was permitted to burn for half an hour; it was then easily extinguished with three buckets of water. The quantity of cellulose burned in each of the holes was scarcely two ounces.

I call your attention to this fact because among the many foolish things said about cellulose by those who do not understand its nature or have an interest in decrying it, it has been said that the presence of cellulose on board ship would lead to grave dangers from fire.

The experiments recently made at Norfolk, Va., by the board appointed for that purpose proved that cellulose, even in a loose state and in the open air, burns very slowly and without flame. And, furthermore, one can easily understand that when it is tightly compressed in an air-tight compartment it would burn even more slowly. Again, as a closing argument and one which is most conclusive, it must not be forgotten that the cellulose is placed in the wake of the water-line of the vessel, hence, when a shot is fired into it, the water which follows the shot at the moment of its entrance would extintinguish the fire if any could possibly occur. Please pardon this digression. I shall now return to the Norway experiments.

One of the projectiles made an irregular hole in the cofferdam measuring 14 inches by 8 inches, the other shots making holes 11 inches by 10 inches.

While it is not absolutely exact to say that cellulose completely stops the inflow of water, you can see that in actual practice the small amount of water which enters may be neglected. When the projectile has passed through the cofferdam and the cellulose is in contact with the water, it gives rise to a sort of filtering action, which increases progressively for about an hour in the same degree as the absorption increases in the vicinity of the part of the projectile. However, the cellulose swells up in proportion to the amount of water absorbed. The cofferdam being of fixed dimensions, as the mass within it swells it follows that the elements which compose it are more closely pressed against one another, so reducing the passages and arresting the inflow of water in the measure that the cellulose becomes soaked. The leaking through always begins with a single drop, and I have seen cases where this drop did not appear for an hour.

In the Horten experiment the shot-holes were immersed in water to a depth of 4 feet, when the following was noticed:

The first drop of water came through the largest hole in about 6 minutes, through the second hole in about 19 minutes, and through the third hole, in the case where the shell had not exploded, in about 38 minutes.

At the end of 30 minutes there flowed through the three holes 2½ gallons per minute, and at the end of an hour 3¼ gallons per minute. In a very little time after, the flow was reduced to 2 gallons per minute for all three holes. It is evident that this small quantity of water could easily be handled by a small hand pump, and that it is insig-

nificant when compared with the torrents which would flow through a hole 14 inches across under a pressure of 4 feet.

As yet no vessel protected by a belt of cellulose has been in actual combat, so that we cannot judge of its action in battle. Recently the Danish government has made a daring experiment which proved its efficiency and at the same time justified the confidence which it had inspired in those who knew it. In May of last year, the last man-of-war built at the Amerger Foelled shipyard at Copenhagen having a belt of cellulose, had a six-inch shot fired through the port bow, the shot coming out on the starboard side. The vessel then steamed about for three hours at a speed of sixteen knots per hour and with the water rising over five feet above the shot-holes. The cellulose proved so effective that at the end of the three hours less than fifty gallons of water were collected in the ship. (See figure.)

At about the same time, during the French manœuvres, the cruiser Surcouf was run into by a torpedo-boat which made a hole 12 inches in diameter in her bow. The boat sank, but the cruiser, thanks to the cellulose, only took aboard an insignificant quantity of water.

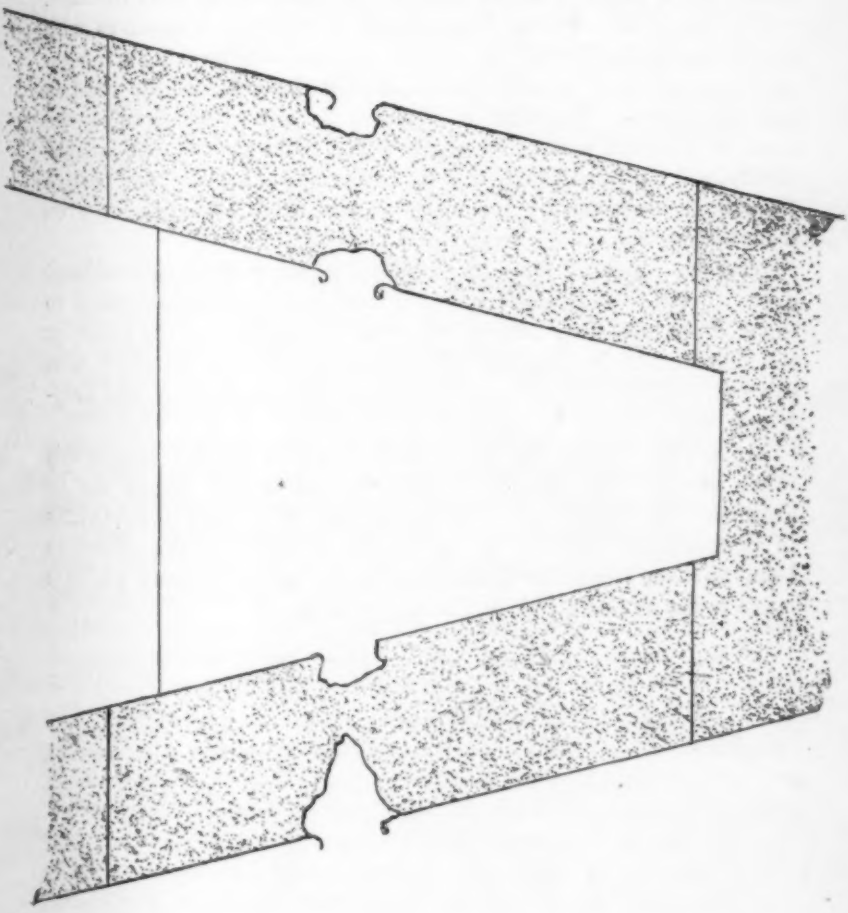
A few weeks later, this same cruiser Surcouf, which formed part of the French squadron when visiting the Scandinavian ports, was run into by the British boat Cormoran during a heavy fog. For the second time upon the same vessel the cellulose filled its role of protector, while the English vessel would have sunk beyond doubt had not the Surcouf gone to the rescue.

I will now refer to the probable use of cellulose upon vessels of the merchant marine. In the near future the passenger steamers will be obliged to follow the path already pointed out in the man-of-war.

It is certain that the system of subdivision into a great number of compartments, which has been in use for several years in the building of large passenger steamers, is the first step towards greater security, but we have actual examples where the enormous vessels have been sunk in spite of their water-tight compartments.

It is evident in certain cases where bulkheads are broken in and adjacent compartments thrown into communication, where the water pours into the vessel, extinguishing the fires, stopping the engines and causing terror and madness in the bravest, the water-tight compartment system is not all-sufficient to ensure buoyancy, because the water-tight bulkheads no longer keep out the waves.

COUPE HORIZONTALE À TRAVERS LA CELLULOSE APRÈS LE TIR.



If by means of a belt or wall of cellulose a protection can be found against the devastating effects of an explosive projectile passing entirely through the belt, how much stronger may be our faith that this protection will be efficient when in place of such an engine of destruction we have only to withstand the shock of wreckage or rocks, which smash, crush or break, but do not pass entirely through.

There may be laws requiring vessels to provide themselves with night-signals, fog-horns and the most powerful steering arrangements, to reduce their speed and to follow the rules of the road in fog and storm. Whether it conform or not to these rules, the steamer provided with cellulose, in virtue of its consequent unsinkability, will have nothing to fear from the blows that she may receive from reefs forgotten by the chart-makers, from icebergs, or even from a blow from another vessel.

In these times of feverish competition, where ship-owners bend every effort to swell their passenger lists, some calling attention to the excellence of their cuisine, others to the comfort of the vessel or the shortness of the passage, the palm must be given to those who can say: "Upon our vessels, guaranteed against sinking and shipwreck, YOU CANNOT DROWN."

A great nation like the American should take the first step in this much needed development of safety at sea, and I should not be astonished to hear at any moment that one of the great ship-yards of Pennsylvania intended to build a fleet of vessels of this nature, to bring to these shores the hundreds of thousands of visitors who will come to the World's Fair at Chicago in 1893.

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

OFFICIAL REPORT ON THE BEHAVIOR OF THE U. S. S. BALTIMORE.

By Captain W. S. Schley, U. S. Navy, Commanding U. S. S. Baltimore.

U. S. S. Baltimore, 1st Rate,
Navy Yard, Mare Island, Cal., *January* 6, 1892.

Sir:—After an experience extending over two years and a half in this vessel, during which time she has served in all climates and in all weathers, over an area of the globe embracing more than one hundred degrees of latitude and longitude, it is deemed proper that a report should be submitted to the Department, setting forth that her behavior under all circumstances has been most satisfactory, and that her adaptation to the service has been fully established. It is only just to her builders to state that the workmanship upon her has been found to be excellent, and does them, and through them the country, much honor.

Her stability as a gun-platform, at sea under all circumstances of weather, is superior to that of any ship I have ever served in. Her speed, comfort, and performances under every condition of wind and weather are unexcelled; and, in her class, I question if her superior as a fighting machine exists in the navies of the world. In some respects her fittings might be improved in the new vessels now building, and in this view the remarks which follow are suggested, with the hope that they may not be without their value to the Department. Her defects, where any exist, are merely details, and in this view I will treat them under their various headings, suggesting in all cases a remedy.

COALING FACILITIES.

In my communication of November 29, 1890, from Naples, Italy, I reported the actual time needed to take coal from the lighters into

the bunkers on the occasion when it was required. Subsequent experiences at various other times when the ship has been coaled have sustained the conclusions then reached, and have in no particular varied the results already reported. With more experience, however, in the open roadsteads of Gibraltar, Cape de Verde Islands, Valparaiso, Iquique, and Callao, it has been found that grave objections arise to taking coal from lighters through side-ports into bunkers, on account of the constant swell in these places. It has been found that the rolling swell in all these ports sends the heavy lighters so violently against the ship's side that the stages are unshipped, ash-chutes are smashed, and much time is lost in waiting and watching for smooth times when working, to pass coal safely or surely from lighters to men on the stages, and so into the side-ports to the bunkers.

In most modern ships of other navies that we have met, this plan of coaling appears to have been abandoned for the better and quicker one of taking in over all, and then passing it through chutes extending through the spar-deck to the berth or gun-decks, as much cleaner, more rapid, and most convenient. Under the present plan on board this ship, there is little comfort for officer or man during coaling, on account of the blinding dust which covers the ship inside and out, penetrating every corner and place.

These discomforts might be endurable if limited to a day or two, but when extended over a week, it suggests an annoyance almost intolerable. In marked contrast I would state, that when this ship was in Gibraltar in February of 1891, one whole day was needed to take on board about one hundred and fifty tons of coal. In the same interval of time the great British ironclads Howe and Camperdown took into their bunkers over all about seven hundred tons. While this ship was covered outside and inside with coal-dust, in these ships mentioned it was confined to the spar-decks. The merits of the two systems in cleanliness and efficiency would seem to require no comment.

OUTSIDE ASH-CHUTES.

The chutes on this ship's side, extending from a point near the top of her rail to the water-line, to dump ashes or other refuse, cause much annoyance and discomfort at sea when steaming in moderate winds on the beam or bows, from the seas catching in the angles at the ship's side formed by these chutes, from which it is thrown on board over the rails into the gangways, gun-sponsons, and on to the

guns, so that the decks are constantly wet, forcing men and officers to seek cover under the poop or forecastle-decks, crowded together in a small space. Passing fore and aft at such times results in thoroughly drenching all who attempt it. The same may be said of all projections on the ship's side, such as lips to all the scuppers or drains, though less marked, but which add material resistance to the ship's speed at such times.

The remedy for these evils appears simple if the number of chutes is reduced to two on each side, built on the inside and delivering at the water-line as in all the modern merchant steamers, with a system of overhead trolley railways converging to the two chutes to dump ashes from the fire-rooms below. All scuppers or drains now built on the inside of ships should deliver at the water-line in round orifices to reduce friction resistance and to prevent lodgment of the water that now comes on board in showers, even when steaming in moderate or light winds.

If these chutes were removed from this ship it would be easy to rig a wooden chute sufficiently long to project well clear of the ship's side, to be shipped when needed and removed when not in use.

ANCHOR AND BOAT DAVITS.

In order to obtain a fire directly ahead for the bow guns in these cut-away fine-lined ships, our experience has shown that only one anchor-davit would be needed in place of the two now on board, if placed in the midship line, fitted to swing over either bow, with drift enough to land the anchors on the anchor port. If sheet-anchors are carried, a second davit, of similar design, placed amidships abreast of them, with range sufficient to handle and stow these anchors, would result in saving both weight and expense, and, at the same time, would increase the ease and efficiency in all work with the anchors.

The system of straight, upright, unwieldy boat-davits pivoting transversely on the outside of the ship to land boats in cradles on the gallows-frames has not worked well or efficiently in this ship, for want of some modern appliance to rig them in or out with the heavy boats hanging on them. Being obliged to use ordinary old-fashioned tackles for this purpose, it often happens when there is the least motion that these davits start in or out with much violence and with occasional damage to boats as well as davits. The danger to life is constant whenever they are worked as they must be in this way.

The remedy for this appears simple if a sufficiently strong davit or derrick is substituted to ship through the top of the hammock netting, to step in a heavy saucer securely bolted in the spar-deck waterways, and so rigged as to pivot in a circle about itself with a curve similar at the top to the ordinary side davits of quarter-boats. Boats hoisted to such davits or derricks are easily swung into cradles on trolleys, or out over the side when lifted from them. Such derricks would then be available in coaling over all in these mastless ships, when it is sometimes difficult to improvise suitable means for such purposes.

ANCHORS.

The anchors supplied to this ship are of the Dunn type of cast steel. During the cruise there has been afforded the fullest opportunity under all circumstances of wind, weather, tide, and bottom to fully test their usefulness. It has seldom been necessary to let go a second anchor, and in no instance during the cruise has the ship ever dragged, no matter what the strength of the wind and tide may have been. An anchor, therefore, which never fouls and never drags under any circumstance in service must be superior to all others.

Lying in the Delaware, September, 1889, in a heavy gale with 60 fathoms of chain and a strong tide, the ship was perfectly secure and safe. Again, in the outer harbor at Copenhagen in October, 1890, lying in about 6 fathoms with 60 fathoms of chain and one anchor during a heavy westerly gale, the ship was perfectly secure and did not drag or foul her anchor. Again, in Lisbon, anchored in 20 fathoms of water with 60 fathoms of chain and a single anchor with a strength of tide during springs amounting to five knots an hour, this ship lay for ten days, during which there were strong northerly and easterly gales. There was no dragging, and on weighing, the anchor was clear. In Montevideo, in March, 1891, in a heavy gale, the ship lay securely and safely with one anchor and 60 fathoms of chain, and when hove up was not foul. At Valparaiso, lying in 36 fathoms of water with one anchor and 105 fathoms of chain, the ship rode out several northers of considerable severity accompanied by heavy seas.

Remaining therefore in port with a single anchor down and a moderately fair scope of chain out for weeks under all circumstances, this ship has never dragged nor has the anchor ever been found to be foul when hove up. I can say, therefore, without hesitation that the Dunn anchor supplied to this ship is the most reliable and safest anchor that I have ever known in the navy.

MILITARY TOPS.

It has been found in this vessel that the guns in her military tops, placed above the tops of her smoke-funnels, are of little use with the wind ahead or astern on account of the volume of smoke and intense heat which envelopes them. Owing to this inconvenience, we have always exercised at target practice with the wind abeam to avoid this difficulty. During action with forced draught and a head or stern wind, either one of the two tops would not be habitable for the smoke and heat, so it is believed that the more favorable position for them would be at some point on the military masts below the tops of the funnels, clear of the smoke and high enough above the deck to secure both depression and range of fire sufficient to be fought under all circumstances against the open decks of ships or to be used effectively in the event of attacks by torpedo-boats. The great advantage of rapid-fire guns in these elevated positions seems too important in modern actions to be left to the hazard mentioned, when by a slight change their value and efficiency would be so largely increased.

VOICE-TUBES.

These most necessary means to communicate from the bridge of this vessel with the engine-rooms or with men in compartments below, have been found quite often to transmit sounds or commands unreliably and indistinctly. With the wind ahead or on the beam, the noise made by its whistling through the rigging, or by the swash of the sea alongside, at times makes it extremely difficult to hear distinctly or with certainty, or to transmit with clearness orders below, owing to the small diameter of these tubes and their small mouthpieces, as well as the large number of turns they make at right angles below to avoid obstructions met in the route they follow. Experience has shown that all such tubes for transmitting distinct words should be at least two (2) inches in diameter, terminating in large open mouthpieces, and when necessary to deflect their direction below, all turns should be the arcs of circles. Signal-bells, used to attract attention on deck or below, should be gongs at least six inches in diameter, set to a note easily distinguishable from all other sounds, and of such strength as not to be absorbed by the noise of the wind or sea. I am convinced that the distant service telephone with their improved transmitters would be more reliable and certain in communicating on shipboard. During gun practice the small voice-tubes are almost useless owing to the inrush or the exhausting

of the air incident to heavy concussion. At the beginning of the new departure in construction, voice-tubes were the best means suggested. I believe the telephone an improved system of communication.

ELECTRIC LIGHTING.

The electric plant of the vessel has, in the main, worked rather well. The chief difficulties appear to have been found in the steam separators and drain-pipes leading from them into the feed water-tank. It occasionally happens when changing steam from one boiler to another that quantities of water from pockets in the long steam-pipes leading into the dynamo-engines rush over into the cylinders of these small high velocity engines, with danger and damage to them on account of the drain-pipes being rather too small to relieve the trap in time to save the machines. Constant and incessant watch is necessary to prevent these accidents, even though the drain pipes are now larger than originally designed. The system of lighting and wiring of the ship is most admirable, though the efficiency of the system would be greatly enhanced in value, if in addition, storage batteries could be added so as to insure the maintenance of light for at least twelve hours, in the event of accidents to the machines from the causes mentioned.

Early in the cruise the fact was developed that the brush and commutator surfaces were insufficient for the work imposed. The result was much sparking and consequent wear on the surfaces of both. The new commutators of larger areas with more brush surface have improved this feature to a marked extent, but at times and from causes that seem almost beyond explanation sparking in a modified degree is still observed, though not to any injurious extent. As the surfaces of both improve, increased efficiency and satisfaction have resulted. All repairs have been effected by the force on board, and it is a pleasure to state that this important addition to our need and comfort is much more efficient to-day than at the beginning of the cruise. The search lights are much improved in excellence and brilliancy. It is recommended that they be used with about 45 volts at the lamp, and this uniform voltage is supposed to be maintained by the dead resistance boxes in the circuit. These boxes, however, do not fulfil their purpose, it being ascertained to be immaterial whether the whole or half of the resistance is thrown in, as indicated by the voltmeter outside them in the circuit. Practically, in working one light we have found it better to run direct from the switch-board

with about 45 volts, but with two lights in circuit it is found more difficult, so that the boxes are then used. This defect in the boxes is not to be regarded as an adverse criticism upon the lamps themselves, the power of which depends in a large measure upon the focusing arc and the form and position of the crater at the carbons, where most practice is required to properly manipulate the light. Lieutenant Sturdy has been able with the force on board to make all needed repairs or changes required to secure more efficiency in the excellent machines supplied to the vessel.

BATTERY.

This important feature of the ship is admirably arranged and is carried with the greatest ease and safety. The carriages have worked most admirably, leaving nothing to be desired or suggested. I am sure, however, that her energy of fire and formidability could be enhanced by increasing the number of her secondary battery to twenty guns instead of fourteen that she now carries. There is ample room on the rails, forecastle, and poop-decks for their accommodation, and abundance of room below in her Hotchkiss lockers to stow the necessary ammunition. The destructive effect of a concentrated fire from machine and rapid-fire guns on board modern ships in the future is deemed to be so important as a factor of success in action that it is believed of sufficient importance to recommend a large increase in their number on board this ship. In most of the foreign ships we have fallen in with during the cruise this feature has been observed most prominently as a later improvement. In the matter of supplying the battery during action we are at some disadvantage in handling the ammunition for our eight-inch bow and stern guns by hand in exposed positions. These means are too slow, although in some respects hardly avoidable with the after-guns, as the scuttles from the magazines are not continued on to the spar-deck, but end on the berth-deck amidships several feet distant from the scuttles extending to the poop-deck to supply the after-guns. But with quick-firing guns this disadvantage is so serious as to suggest a change by which the ammunition could be delivered from the magazines directly to the guns, as is done with the forward pair. The celerity of delivery, now so important, might also be improved by the aid of a small electric motor placed in or near the magazine passages operating the lifts.

With the supply to the broadside guns there is no delay or diffi-

culty, for the reason that the ammunition being much lighter is much more easily handled and more rapidly passed to the delivery chutes near each of these guns. As the quantity of ammunition delivered to these guns in a certain time is much more than could be fired away in the same interval, there would seem to be no need for any change in the manner and system of supplying them.

ENGINES AND BOILERS.

These splendid machines have worked throughout the cruise almost faultlessly. The material, work and finish upon them show a high order of capacity and integrity. Wherever defects have occurred it has been rather in the original design, though in this respect, if we except pumps, main condensers and the system of drainage, there has developed but little to occasion complaint. Most of the steam pumps are of English design and of the yoke pattern and are vertical; they get out of order easily and are difficult to overhaul on account of having to be taken down before they can be taken apart. Pumps of American design ordinarily used on board our steamers are without doubt to be preferred. All the pumps for clearing her water-tight compartments of water are located low down in the engine-room compartments, so that if either of these should be flooded the whole drainage system forward or aft would be rendered useless. There have been quite a number and variety of accidents under this condition to demonstrate the importance of locating these pumps outside the compartment system of the ship, so that their usefulness be not imperiled by injuries that would involve their use at critical moments.

Referring to the main condensers, it occurs to me to be inadvisable that the air-pump should be attached to and driven by the low-pressure piston. The slightest injury to the connecting piston-rod would disable one engine entirely, but an inconvenience almost as serious is imposed, in being obliged under the circumstances to start the main engines, often at inconvenient times, to obtain a vacuum, and, in order to maintain it, to constantly keep turning the main engines over every few minutes. Separate air-pumps worked independently of the main engines would be an undoubtedly desirable advantage, wherein some danger would be avoided and much inconvenience overcome.

Condensers of cylindrical shape would be a marked improvement in this vessel, on account of the less room they would take, and the more room they would afford to move and work about the engines.

The system of drainage in its extent and general application is good, although it is made to depend upon pumps that are located in compartments liable to be filled with water themselves, instead of outside of the systems that it is intended they should clear. We have experienced some inconvenience when it has been necessary during a cruise to refit the piston-shoes of both engines. These shoes being filled on their friction surface with white metal squares, to save the bottoms and lower quarters of the cylinders from undue wear, were found worn down to such an extent that it has been necessary to refit and refill one or more of them. As this operation is one in which great care and some time are necessary, the ship was practically disabled during the period required to complete them. If each of the new cruisers were supplied with one spare set fitted for one engine, it would be a simple matter to replace an injured set in a short time while renewing on board ship the metal in the worn set; or, perhaps, if these shoes were made of cast iron softer than that of the cylinder, I am of the opinion they would answer quite as well.

We have met with much inconvenience in using water from the forward feed-tank, which is the receptacle for all condensed steam from the dynamos, heaters, steering, anchor, and auxiliary engines. The oil used in the cylinders of these machines is carried over in the drain-pipes to the feed-tank and from there fed into the boilers, where it deposits in a thick gummy scale that must in time work injury to the main boilers. This tank could be improved by a filter, or by some means to drain off the oil from the top, so as to prevent so much of it being carried over into the boilers in the feed-water.

The two auxiliary boilers of this vessel are too small to run the dynamos, make fresh water, heat the ship, and to use in cooking. The consequence has been that we have been obliged during the entire cruise to keep steam on one of the main boilers for these purposes, and to devote the auxiliary boilers solely to making fresh water for drinking and cooking. It will require for the purposes mentioned above, when not under way, a boiler of at least 200 to 250 H. P. in a vessel of this size, in addition to supplying the main boilers with fresh water for their use, and none other ought ever to be used in them; perhaps an evaporator might readily take the place occupied by one or both of the auxiliaries.

I would suggest that the ash-hoisting engines now placed in small cuddy-holes on the berth-deck, where it is excessively hot when under steam, and where there is not room enough to keep them in proper

order, be transferred to the uptake or drum rooms, where there is abundant room, more protection, and more light in making needed repairs.

It is especially important that all openings under the engine and fire rooms into the double bottoms, except those well up on the ship's sides, should be raised so that the manhole cover will be at least three inches above the bottom of the limber-holes, in order that when necessary to go into these compartments, the water in the bilges may not be admitted, as now happens.

The issuing and tool room of the Engineer Department, whenever it is possible, ought to be located between the forward engine-room and after fire-room, both on account of convenience and for saving time in getting stores and tools when work is going on. Much valuable time that is now taken in getting these things could then be devoted to work.

OFFICERS' QUARTERS.

In olden times, when sail was the motive-power of ships, there were excellent reasons for placing the officers' quarters of ships in their after-parts, in order that the captain might always have the helmsman and the sails under observation, and the watch-officers close to their stations of duty; but in this age of rapidly moving steam cruisers of great length, the deck-officer as well as the helmsman are transferred to stations of duty forward, that greater security may result by this change of position. It would seem then that the same logic that fixed their quarters in the first instance ought to do so in the last, that the officers might live nearer where they are required to be on duty when under way. It often happens that the interval of time between the discovery of danger and the quick decision to avoid it is so short that there is not time enough to allow the captain to traverse the whole length of these long ships, from quarters in the stern to the bridge in the bows, before deciding what should be done. It is possible that instances may occur in which this action delayed from such cause may prove too late. As the seat of control has now gone to the forward end of the ship, the quarters of the officers should follow, to increase the efficiency of command, and to avoid accidents that are possible under present circumstances. As efficiency is the first consideration, it ought to prevail against prejudices which live longer and stronger with us than all else. This change would really be no more radical than that in which the mastless ships of to-day have superseded the full-powered sailing frigates of other days.

MEN'S QUARTERS.

There has been a growing tendency in late years that finds fuller expansion in the later cruisers, to increase the accommodation of officers by encroachment on those of the men. In this respect the Baltimore is a good type to use in illustrating this position, for in her the officers' quarters, with the ship's offices, pantries, etc., take up quite half of the capacity of the berth-deck of the ship. Commencing first with the space devoted to the Admiral and Captain, it could be reduced quite one-half and then be commodiously large. But if both were placed under the poop, as might easily be done, then the wardroom, junior officers' quarters, pantries, etc., could be fleeted aft at least thirty feet or more to afford a larger berthing space for the three hundred and thirty-five men. With the improved systems of ventilation of the new ships there is hardly any suffering, and no injury to health as formerly, but there yet remains much unnecessary crowding together that could be remedied in this ship, and I think in all others, if the officers' quarters were reduced in some such proportion as those of the men.

ORGANIZATION.

With most of the conditions changed by the disallowance of many of the rates usual in ships of war of the older type, it was evident in assuming command that a change of organization was not only forced by this fact, but by many circumstances incident to a type of ship that bore scarcely any resemblance to the older beyond the general external likeness. With so much complicated apparatus that had to be attended to in the new ship, substituted for the many old things that might have been neglected in the older, it was evident at a glance that a change was at hand that had to be met. A little reflection soon fixed the fact that in the modern ships as fighting machines most of the impediments of the older vessels had been removed to make way for battery and engine efficiency, which suggested them as the units upon which the newer organization ought to be constructed. With this end in view, it was decided to establish this organization first, and from it to derive all others in order to secure the desirable object of placing men who are at the same gun-division in the same infantry company, in the same boat, in the same mess, in the same stations, and to associate them in the same work of cleaning, where they were under the control of gun-captains rather than captains of the several parts of the ship. If there is value

in the fact that *camaraderie* in the fellowship of arms is induced by association in the same duties, or in the same exposures, such an organization tends to bring this out fully. The excellent condition of the ship and her appurtenances during the cruise will stand as an evidence of the fact that this organization has had good results.

In these large ships where the duties of the Executive Officer have been made most difficult by the enormous complication and subdivision into water-tight compartments, there are hardly hours enough in a day to attend to the duties required under the new conditions. To relieve this to some extent, the scope of duty of the divisional officer has been enlarged so as to include the care and responsibility, not only of their guns and crews, but also of the cleanliness and good order of the decks, paint work and fixtures within the area included by their divisions. All officers in charge of departments below decks are held responsible for duties in and about them and are required to attend personally or through subordinates to many things that formerly consumed much of the Executive Officer's attention.

In the organization of the battery of this vessel the marines have been assigned to the secondary battery to utilize a force whose rifles in action would be useless, but they have no part in the organization of the crew for cleaning or coaling, in consequence of prohibitive orders and circulars. To some extent they are a privileged class who make dirt, but are not cleaners, as every man on board ship ought to be. It is to this distinction that some of the adverse criticism of their need is due. There is nothing in the character of their duties on board that ought properly to excuse them from the fullest participation with the men in all the ship duties that tend to develop the fullest efficiency of the vessel as a fighting machine.

ENLISTMENTS.

The experience of this cruise in a vessel fitted with military masts, wherewith some of the grades of petty officer are unnecessary, suggests the idea that it might be better to combine all distinctive rates into three classes on enlistment. For example, instead of enlisting men in the rates of master-at-arms, boatswain's mates, machinists, carpenter's mates, gunner's mates, etc., after three consecutive enlistments as at present, it would appear more logical to separate the existing grades of petty officers into three distinct classes, to be known as 1st, 2d, or 3d class petty-officer, and to be enlisted in these grades at a rate of pay nearly equal to that now received under such

divisions in the pay table. Then when these petty officers of the several classes are transferred from receiving-ships to a cruising vessel, it would be within the power of the commanding officer to rate them captains of tops, coxswains, quartermasters, machinists, etc., which properly are rates incident to their service afloat rather than rates in which men ought to be enlisted on re-entering. It can occur in the short period of twelve years that all the most valuable men of the navy will be found re-enlisted in the superior grades of master-at-arms, yeomen, machinist, etc., to which the largest rate of pay is attached.

Under the system suggested, it is believed that much greater efficiency will result to the service in the establishment of a plan which will separate the grade in which a man is to enlist, from the actual rate in which he is to serve after assignment afloat.

If the estimates of men by all commanding officers could be the same in fixing fitness for rates, the present system might answer, but as in this matter the widest divergence of opinion exists, it does not appear just that the judgment of any one officer in fixing the status of a petty officer in a certain grade should be the inflexible rule to govern all others.

When, however, men have been re-enlisted in the grades of petty officer here suggested, they should be entitled to mess in a separate place with a cook attached to their mess, away from the men they are expected to command, and on each re-enlistment under continuous service there might be an increase in the gratuity pay somewhat greater than that in the grades of seaman, ordinary seaman, etc.; and to fix the attachment of these and all other men to the service, I would suggest that leave of absence be accorded to all honorably discharged men after each cruise, as is the case of officers who desire it.

This idea seems to me to be one that would fix in the men's minds and thoughts that they really belong to the navy as a part of its organization in much the same sense as the officer.

RANGE-FINDER.

During the cruise in all target practice, this instrument has been found of the greatest value in accurately determining the distance. On the last occasion of practice in Coquimbo Bay, when the apparatus was not used on account of the battery of dry cells being out of order, a marked difference was observed in the practice where gun-

captains depended upon their own judgment to determine distance rather than upon the range-finder. The less accurate practice of this occasion clearly demonstrated the value of the apparatus used in connection with the modern high-power artillery.

From my observations with the instrument on board this vessel I am convinced that it is an indispensable part of the ordnance outfit of all our new ships. Four instruments, two on each side, so protected by projecting sponsons as to afford a range of nearly 180° would improve the present plan. The forward and after pair to be connected so as to determine the range of vessels directly ahead or astern. The experience of this ship with the instrument shows further that the ships, in contests of the future, supplied with the Fiske Range-finder would possess an enormous advantage over those in which the distance had to be determined in the old way by gun-captains whose judgment would be affected by the excitements and tumult of battle. Indeed, I think I do not overstate its value when I express the opinion that in the naval conflicts hereafter, where ships are equal or nearly so, combats will be decided in all probability in favor of the ships with range-finders, or in case both contestants possess these instruments, actions can last but a few minutes at most, and during this short interval the destruction would be terrific.

COLOR FOR SHIPS.

During the cruise it has not been our experience that white is the best color to paint ships, either for neatness or for service. It is extremely difficult to keep the modern ships in order when painted this color, where it is necessary to coal every fortnight when making a passage, or when lying in the damp and sticky ports of the tropics. It is the most conspicuous of all colors at night and therefore not at all adapted for service in war. It is much more expensive because it is necessary to paint so frequently to maintain a respectable appearance.

At the first signal of war it would be necessary to adopt some neutral tint akin to that which the French have chosen for their coast-guard ships. This shade is the lead color with a slight tinge of green similar to that atmospheric tint observed near the horizon during the morning and evening. Ships painted this color blend most harmoniously with the sky coloring and are almost indistinguishable after darkness intervenes. Of all colors this one appears best adapted to war uses, and as all modern ships are intended to be

ready at all times for war, I would recommend this color for all ships, boats, funnels and spars, so that there should be no necessity to repaint ships in the event of war to complete their readiness for it.

The great precision of modern arms against well-outlined targets makes their color a matter of the greatest importance. The shade I suggest is the best I have yet seen for war vessels.

During the struggle just ended in Chili, the torpedo-boats Almirante Lynch and Condell were painted this color, and on two occasions, one at Iquique and the other at Coquimbo, both these vessels entered these ports at night and were scarcely visible only a few hundred feet away.

PERFORMANCES OF THE BALTIMORE'S ENGINES AND BOILERS.

The adjoining tabulated data (see table next page) represents the performance of the ship under circumstances of service, with the state of the bottom in good, fair, and bad order. It will be observed that the per cent of slip varies considerably with the bottom in foul or in clean condition, while the increase in the coal consumption as shown in the last line is immensely increased without any gain in speed.

The economical speed of this ship is shown to be about 10.26 knots with a coal consumption of about 158 tons to the thousand knots, or about 40 tons per day or about 3600 pounds per hour. At this rate of speed each cylinder of the engine does the fullest economical work at the least loss of speed by the slip.

Though the data here supplied furnish a curious and instructive study of results in actual service, in all cases there appears a larger consumption of coal per horse-power than originally calculated. This reduces her steaming radius largely, and is all the more important in demonstrating the fallacies upon which these calculations have heretofore been based. This table is submitted as an instructive study of her performances.

Very respectfully,

(Signed) W. S. SCHLEY, *Captain, Commanding.*

THE HONORABLE SECRETARY OF THE NAVY,
NAVY DEPARTMENT, WASHINGTON, D. C.

Date.	Revs.	Speed.	Slip per cent.	Coal used per hour.	Coal, tons per day.	H. P.	No. Hours.	Tons 1000 kts.	Days 1000 kts.
July 18, '91	30	4.7	26.7	1683	18.00	203	12.0	159.8	8 days 21 hours
May 25, '90	40.2	7.1	16.4	2140	22.9	524	5.0	134	5 days 21 hours
July 16, 17, '91	45.0	7.58	20.0	2525	27.05	715	17	149	5 days 12 hours
August 25, '90	50	9.3	12.2	3713	39.78	806	24	178.5	4 days 12 hours
August 24, '90	50.9	9.1	15.2	3300	35.35	860	8	161.8	4 days 14 hours
May 15, '91	50	9.0	15.0	4189	44.88	757	19	207.6	4 days 15 hours
July 16, '91	50	8.5	19.8	3215	34.44	992	6	166.9	4 days 21 hours
May 17, '90	54.7	10.0	13.0	3705	39.7	919	24	165.4	4 days 4 hours
May 19, '90	55.7	10.26	13.0	3657	39.18	971	24	158	4 days 1 hour
July 23, '91	55	9.1	22.0	3600	38.57	1240	3	177	4 days 14 hours
November 13, '90	60	11.2	12.0	4268	45.73	1301	6.7	169	3 days 17 hours
December 11, '90	60	11.0	13.6	4100	43.93	1238	2	177	3 days 19 hours
April 2, '91	60	11.66	8.4	4705	50.41	1284	24	180	3 days 14 hours
March 8, 9, 10, 11, '91	60	11.4	10.5	4220	45.00	1204	96.9	165	3 days 15 hours
May 19, '90	60.5	11.5	10.4	4200	45.00	1194	3	163	3 days 16 hours
June 16, '90	65.2	12	13.2	5468	58.6	1495	5	205	3 days 12 hours
April 27, '90	80.6	15.1	11.7	6100	65.3	2825	4	170	2 days 18 hours
August 21, '91	84.1	13.6	23	10194	109.2	4158	6	337	3 days 2 hours

U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ELECTRIC WELDED PROJECTILES.

MANUFACTURED BY THE AMERICAN PROJECTILE COMPANY, UNDER THE PATENTS OF PROF. ELIHU THOMSON AND WILLIAM MAXWELL WOOD, U. S. N.

BY HIRAM PERCY MAXIM.

Ordnance experts and military men generally have lately been much interested in a new method of making projectiles. This is the Electric Welding Process, used by the American Projectile Company of Lynn, Mass., and from the success so far achieved, it certainly seems that an important step in advance has been made in the manufacture of steel shell.

The American Projectile Company was organized a little more than a year ago to engage in the practical manufacture of all kinds of projectiles, and having been given contracts by both the navy and army, have, since that time, equipped their shops with the necessary special plant and are now, after a great deal of experimental work, manufacturing on a regular business basis.

All ordnance experts well know the tedious and difficult processes at present used in producing the different kinds of forged steel projectiles. Steel castings for this purpose having long since been abandoned on account of the difficulty in obtaining the desired results and the expense of the castings themselves, it has been, up to the present time, a question of high grade and expensive armor-piercing projectiles and ordinary cast-iron ones for common use. It has been rendered possible, by the invention of electric welding, and is now one of the aims of the American Projectile Company, to produce a forged steel shell at about the same price as it now costs to manufacture the common cast-iron projectile. This is accomplished in the following manner:

1. Hollow steel blooms are cast and from them is rolled out a thick-walled tube, having the approximate finished dimensions of the body of the shell. This is then cut into suitable lengths, and to the short blanks thus made are joined, by electric welding, the head and base of the projectile, which have been previously formed in suitable dies. After this is done, the only machining necessary is turning to gauge on the outside, cutting the rotating band-score and the fuze thread and seat. This projectile is afterwards hardened, and thus is produced in this very cheap manner a thoroughly efficient wrought-steel shell. It will be understood that this is not the high grade armor-piercing shell, but a shell that can be used very efficiently against armor of moderate thickness, and will in other respects fulfil the offices of the common shell, at the same time costing no more than the cast-iron now in use. This, of course, is a very important feature, as it will enable the Government, without any additional cost, to fill the magazines with this much better grade of shell, which may, in time of peace, be used for target practice, etc., and still be on hand for efficient service in case of war. The company are now filling two large contracts for the navy for shell of this character—one for 30-pound projectiles for the 4″ rapid-fire gun and the other for 6″ common shell.

Figure 1 illustrates the formation of this projectile, although in this illustration the midships section of tubing should be longer and the head and base pieces proportionately short. To understand the simplicity of the welding operation, it must be understood that it is only necessary to place these three pieces in contact, one above the other, in an electric welding machine designed for the purpose, and by means of the electric current, which is passed from one pole to the other through the joint which is to be made, the metal at this point is quickly heated to a welding heat, and being kept in close contact by mechanical pressure, so unites at this point as to become homogeneous and equally strong with the rest of the metal. The surplus metal, or burr, formed by the pressure, is mainly forced upwards and is removed in the operation of trueing the body of the shell. The operation of electric welding is so simple that it requires no expert to operate the machine, as any intelligent man can be taught in a very short time all that is necessary to produce a weld impossible in any other way. Furthermore, it is feasible to weld the highest carbon steels, steels that are absolutely unweldable by any other process, one to another, or to weld a high carbon to a low

grade steel, or even to wrought-iron. The importance of this in projectile manufacture will be understood when it is seen that the head of a projectile may be made of high grade expensive steel, and as much of the balance as desired of cheaper, softer material. One who understands the difficulties of obtaining a perfect weld when the metal has to be heated in the blacksmith's fire, will fully appreciate the great advantage obtained by this method, where the metal stands fully exposed to view in the open air and comes in contact with no impurities whatever, where the heat can be checked at any desired moment by the simple movement of a lever, and regulated as easily as the turning off or on of steam or air pressure.

These remarks apply to the ordinary operations of welding, but of course there are many forms which are practically impossible to the smith, and among them the tubular sections used in the manufacture of projectiles. The following will illustrate the strength of a weld of high carbon steel:

A six-pounder armor-piercing shell, fired at a recent test, slapped or "key-holed" slightly on striking the plate. It, however, passed through a 4-inch iron plate whole, and when recovered it was found to be slightly bent directly at the region of the weld. The snap, as the shell straightened itself in the plate, had been so great that the square head of a brass plug, which was screwed into the fuze-hole, had actually been broken short off by the blow, leaving the threaded portion in the hole. Of course, this great strain, as shown by the bend, came directly on the section in which the weld was located, and this showed not the slightest sign of fracture.

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

The armor-piercing projectiles of this size are being manufactured in two pieces, as shown in figure 2, and in section in figure 3. In this case no tubing is used. Figure 4 shows one of these projectiles that has been fired through a 4-inch armor-plate. One of the marked peculiarities of these armor-piercing projectiles is the following:

The head section is hardened uniformly all over; the base section is not hardened at all. When the two pieces are joined by the electric welding, one of the features of which is limiting the heat to a short distance on either side of the joint, the shell is placed with a portion of the head in cold water, and thus the heat from the weld draws the temper gradually toward the point, thus leaving the base unhardened, and from it tapering to the necessary hardness at the point. Aside from this simple method of drawing the temper gradually toward the point, it will be seen that the hardening of the head alone is a very much less difficult operation than heating and hardening the whole projectile; also, that temper-cracks and other defects may be very easily distinguished in this portion of the shell before the base is welded on. This is considered one of the very important features covered by the patents of this company.

Another style of projectile now being manufactured is the shrapnel, for the army 3.2-inch field-piece, illustrated in section in figure 5 and in detail in figures 6, 7, 8, 9 and 10—figure 6 being the head forging, figure 7 the tubular midships section, figure 8 the steel diaphragm and central tube, forming, respectively, the powder chamber and the passage from the point fuze to it; figure 9 the base forging, showing the shoulder on which the diaphragm rests, and figure 10 the copper rotating band, which is afterwards shown pressed on the shell in figure 5. The method of making this shrapnel is as follows:

The base piece and tube, figures 9 and 7, are placed in contact in the welding machine and joined together, forming a deep cup; while the weld is still hot, the diaphragm and tube are dropped into it so that the former rests on the shoulder of the powder chamber. The weld is then lightly swaged, thus locating the diaphragm firmly in place. Next the head forging is placed in contact with the open end of the tube and with the small central tube passing into the fuze-hole. This is then similarly joined by an electric weld. Afterwards the upper end of the small tube is crimped over a slight shoulder in the bottom of the fuze-hole. The outside of the shrapnel is then turned to gauge. A small hole is drilled in the head, communicating with the interior cavity; through this the shrapnel is filled with the neces-

sary bullets; next the matrix is poured in, and finally the hole is closed by a small plug which is screwed into place. Before the case is filled with the bullets and matrix it is hardened to give increased rigidity to the thin walls and to increase the number of fragments into which the case will burst. In trial, these shrapnel have given most excellent results.

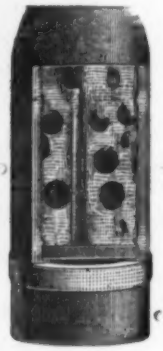


FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

FIG. 9.

FIG. 10.

So far, the largest shell being manufactured by the American Projectile Company are the 6-inch naval common shell above referred to. These weigh, empty, 94 pounds, and have an outside diameter of 5.96 inches, with a thickness of wall of 0.95 of an inch. It is expected, in the near future, that the company will undertake the manufacture of very much larger projectiles, as the only limit seems to be the possibility of obtaining the necessary tube, and arrangements are now being made to have this produced of the necessary dimensions to make as large as 12-inch shell.

It is believed that projectiles of the character described in the beginning of this article will be peculiarly adapted for use in mortar

service against deck armor, etc., as they will have all the advantages of armor-piercing projectiles for penetrating that thickness of armor, and can be produced at a fraction of the cost of the more expensive missiles.

In conclusion, a brief description of one of the welding machines may be interesting. Figure 11 shows one devoted to small size projectiles, such as the 6-pounder armor-piercing and common shell. It stands high from the ground to enable the operator's helper to place and remove the shell being operated on from beneath. After placing the separate pieces of the shell in the machine from the under side, a movement of the hand-lever in front of the operator throws in a set of hydraulic contacts through which the electric current passes to the portions of the shell they enclose. This current is obtained by transforming the primary current of 200 volts and about 250 amperes into a current of ½ a volt and consequently enormous quantity. The current is perfectly controlled by a switch, operated by a foot-lever and in connection with a reactive coil. To carry this great current, heavy copper castings are necessary, which are kept cool by water-jackets and a continuous circulation of water. These water connections, for cooling and for pressure purposes, are shown by the numbers of pipes and tubes at the top of the machine. To give the necessary pressing together when the shell is at the welding heat, another hydraulic cylinder is provided. This is controlled by a lever conveniently placed. After the weld is finished, the assistant quickly carries the shell to a small hammer, where the burr is lightly swaged. It is then placed, head downward, in a shallow vat, to keep the temper from drawing out of the point.

The general construction of all the welding machines is extremely simple, the only thing requiring any particular care being to insure proper electrical contacts on the shell. This cut is taken from a photograph, and shows the operator holding the freshly-welded shell on its jig. This will give an idea of the local limit of the heat after the weld has been made.

In welding larger projectiles, another style of machine is used. This is illustrated by Figure 12. In this case the parts to be welded are placed upon the head of an hydraulic ram, which moves them upward into position as shown. The electric connection in this case is also made by hydraulic plungers in electrical connection with the induction coils, and they are caused to move in or out by means of a valve operated by the T-shaped handle shown near the top. A

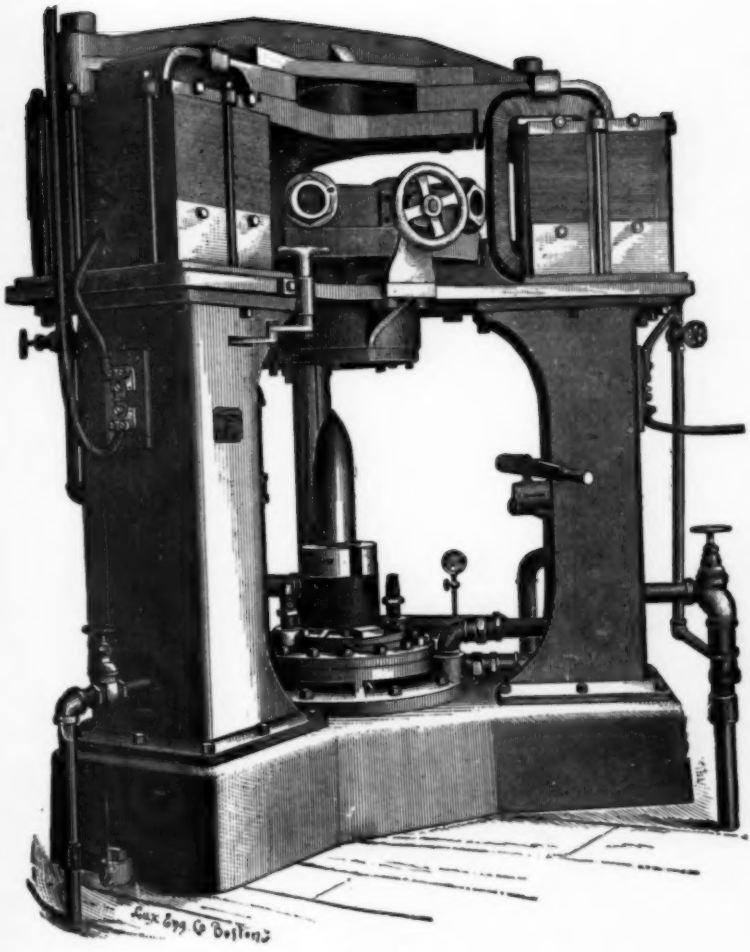


FIG. 12.

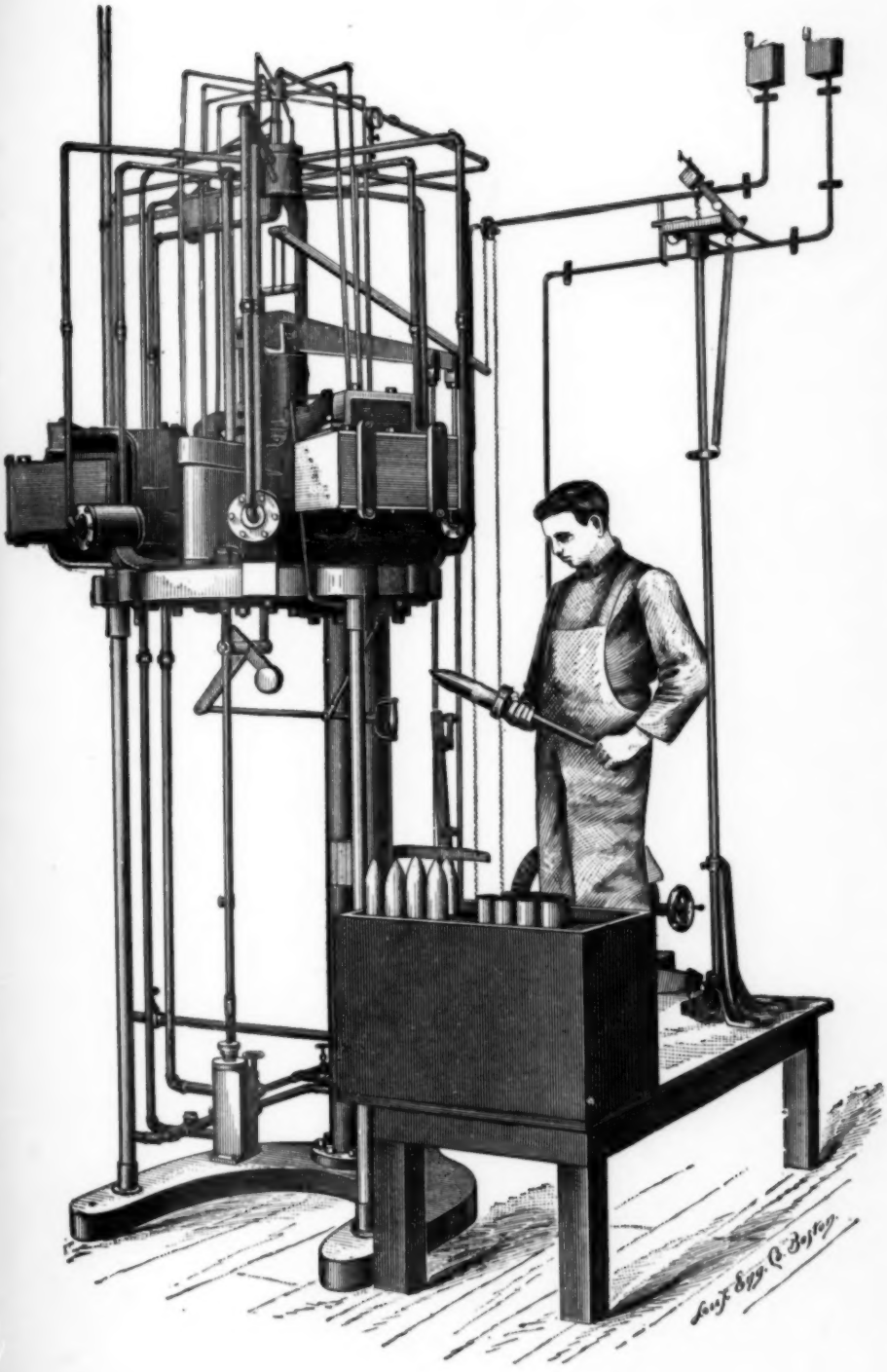


FIG. 11.

foot-lever actuates the switch, as in the smaller welding machine and a hand-lever shown on the right of the machine controls the upward pressure. The work at present being done by this machine is a section of eight square inches per weld, the operation being completed in 3½ minutes.

In describing the tubular shell of the 4-inch type it should have been stated that these projectiles have already been successfully tried against thin armor and have exceeded in results what was expected of them.

A great number of special machines and appliances necessary for making this business a practical and financial success have been designed by Lieutenant William Maxwell Wood, U. S. N., who is also the inventor of this system of manufacturing projectiles.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE INFLUENCE OF RANGE-FINDERS UPON MODERN ORDNANCE, GUNNERY, AND WAR-SHIP CONSTRUCTION.

By Lieutenant Albert Gleaves, U. S. Navy.

It is believed that the introduction of a trustworthy naval range-finder will lessen the necessity of extremely long guns, change the present disposition of the battery, modify the construction of war-ships, and materially alter the conduct of the naval battles of the future.

For more than twenty years guns have been increasing in length of bore. Previous to 1879 twenty-caliber guns with a muzzle velocity of 1400 f. s. or 1500 f. s. were considered quite good enough; but the introduction of hard armor of great thickness called for greater penetrative power in the guns, and this has led by successive steps to the present high-power rifles, 45 and 50 calibers in length, with initial velocities as great as 2800 f. s.

The use of these guns, especially on board ship, is attended with disadvantages which cannot be overlooked. Their increased weight, the greater probability of being disabled by having the chase struck by an enemy's shot, the increased difficulty in the construction of the carriage and in handling the gun, and the extra cost, are serious considerations. Primarily, these guns were designed to obtain greater penetration and accuracy; for in cases where the range is uncertain, the flatter the trajectory the greater the accuracy of fire. If, however, the range is accurately known at every instant, and the gun-captains are kept constantly informed of the exact distance and bearing of the enemy, will the very long guns make better practice than the ordinary gun of 30 calibers? Compare the targets made by the old-fashioned smoothbores with those made by the new guns, and it

will be seen that the great difference in accuracy between the guns is not realized in actual service.

Doubtless it would seem absurd to state that for all practical purposes the 30-caliber gun is as accurate as one ten or fifteen calibers longer, but it is hoped to prove this by the following illustration, in which, for the purpose of comparison, a 6-inch B.L.R. firing a full charge (2000 f. s.) is taken to represent the very flat trajectory gun, and the same caliber gun with reduced charge (1700 f. s.) stands for the other. Let us suppose that both guns are laid upon the same point in a vertical target at a known distance. The elevations of the guns will of course be different, but the lines of sight will pass through the same point on the target. Now, if by reason of rolling or some other derangement both lines of sight are thrown off the point aimed at, and at the same time both guns are fired simultaneously, neglecting the errors of the gun, the two shots will have the same error on the vertical target; that is, their points of impact will be identical on the target; in other words, both shots will pass through the same point. That is, the higher power gun will do no better shooting in the vertical target than the other, and its range error will be much greater. A little reflection will show that this is true, and an examination of the formula

$$y = x \tan \theta - \frac{Cx}{2 \cos^2 \theta}\left[\frac{A_2 - A_v}{S_2 - S_v} - I_v\right]$$

in which y is the vertical ordinate of the trajectory at the range x, will prove it.

The advantage of long guns, then, seems to depend wholly upon the question of penetration.

The penetration of the 6-inch B.L.R. of 30 calibers is estimated to be 10.27″ of steel at the muzzle and 7.57″ at 1500 yards; the corresponding penetrations of the 6-inch B.L.R. of 40 calibers are 11.38″ and 8.39″ respectively. But there are not a half-dozen ships afloat that will keep out the 30-caliber shell and not keep out those of the 40-caliber guns.

Comparing the 30*-caliber* 6*-inch B. L. R.* (2000 *f. s.*) *with the* 40*-caliber* 6*-inch* (2150 *f. s.*), *we find that the penetration has been increased about* 10 *per cent, and that the power of the gun referred to foot-tons per inch of the shot's circumference has been increased about* 16 *per cent; but on the other hand, the weight of the gun has been increased* 25 *per cent, and the efficiency of the gun decreased* PER TON WEIGHT OF GUN *about* 8 *per cent.*

It is generally believed that the fighting range during the greater part of an engagement at sea will be without range finders about 1000 or 1200 yards. And yet our high-power guns, even if 30 calibers, range 7000, 8000 and 10,000 yards. Are we then to be compelled to fight at 1000 or 1200 yards and throw away the immense advantage of such ranges? As long as we have to depend upon individual estimation of distance in the excitement of action when smoke obscures the view it will be necessary to do this, for at 4000 yards the average error in judging distance even on shore is said to be 1000 yards. The possession of a range-finder, however, enables us to utilize the full effect and power of the gun's reach. Knowing the distance accurately extends the fighting range, and having a moderately high-power gun, this will be only limited by the distance at which the gunners can keep their sights on the target.

Many interesting and important considerations follow the great increase in the fighting range. It will decide the question of disposition of weight of metal allotted for guns in favor of large calibers, which means a fewer number of heavy guns rather than a greater number of lighter guns. Discussing the subject of disposition of metal for guns, Lieutenant Meigs says: "The question is one of range. At what range are modern vessels, armored or unarmored, expected to fight? A logical solution of the question of the defensive and offensive power of a ship of war cannot be reached without assuming what the fighting range will be."

In putting our metal into large-bore guns we of course sacrifice very flat trajectories and penetrative power, but we can afford to do this if we increase the fighting range to 3000, 4000, or possibly 5000 yards, and at the same time increase the weight of the shell. If ships engage each other at 1000 yards, more or less, it is obvious why flat trajectories are essential; the "point blank" range of modern guns is 1000 yards, or, to put it in another way, these guns will strike a target 12 feet high up to 1000 yards when the sight-bar is down, and therefore it would not be necessary to touch the sight-bar as long as this range is maintained.

Increasing the range will tend to decrease the side armor of a ship and the thickness of protection in the wake of the battery, since increase of distance means decrease of striking velocity; although, owing to the fire becoming curved, there will be an increase in the thickness of horizontal armor. This saving in thickness of armor will allow its greater distribution for a given total weight; or an

addition to the weight of gun-metal and ammunition; or, if these be deemed sufficient already, to the weight of coal carried.

"The tactical value of a gun depends upon the number of shots it can put in a standard target in a fixed interval of time, upon its power of penetrating or smashing targets, and upon its mine power. . . . The first of these qualities—that of putting a large number of shot into a target in a given time—belongs in a higher degree to small than large guns, because, although the larger shot are usually less deviated by accidents of flight, yet they cannot be delivered so rapidly from the same total weight of metal in guns. The second—that of penetrating and smashing targets—increases with the caliber. And the mine power of shells increases much more rapidly with the caliber—nearly as its cube." *

Thus we see that the gun which satisfies the range-finder possesses two of the three factors which are of the highest tactical value. With regard to the third—rapidity of fire—it must be remembered that in long-range sea engagements the fire will naturally slacken and therefore render this quality of the gun of less importance than it has had heretofore. Again, reducing the speed of firing will give the smoke time to drift away, the target will be more plainly visible and the firing will become more deliberate, a condition most favorable to economy of ammunition.

Now as to the disposition of the guns, and in arranging them to suit the changed conditions imposed by the range-finder, we will find another return to an old order, illustrating the shifting and unsettled nature of artillery questions.

After shell-guns were introduced the battery was dispersed, to minimize as much as possible the effects of a burst between decks. The Gloire (1858), Warrior (1859), and Minotaur (1861), the Italian Formidable (1860), and the Russian Petropavloski (1861) are examples of this disposition of guns. As armor increased, however, in thickness and became harder, the defense gained so rapidly that guns were collected together in turrets, central casemates and armored citadels. This period of naval construction is typified in such ships as the Alexandria (1873), with 12 inches of iron armor; Inflexible (1874), with 24 inches of iron; the French Tempête and the Italian Duilio (1873) with 21.3 inches of steel armor.

The development of rapid-fire guns and the introduction of high-explosive shells made it necessary to again change the battery by

* Naval Gunnery—Meigs. Gen. Information Series, No. VIII, p. 176.

separating the gun-positions as much as possible, and examples of this are seen in the ships built in the last ten years, in such battle-ships as the Collingwood, Victoria, and Trafalgar, the French Marceau and Hoche and the Italian Re Umberto, and in cruisers like the Warspite, Dupuy du Lôme, and the New York. Nothing in the chequered history of ships and guns is more clearly defined than the periods of battery dispersion and assemblage.

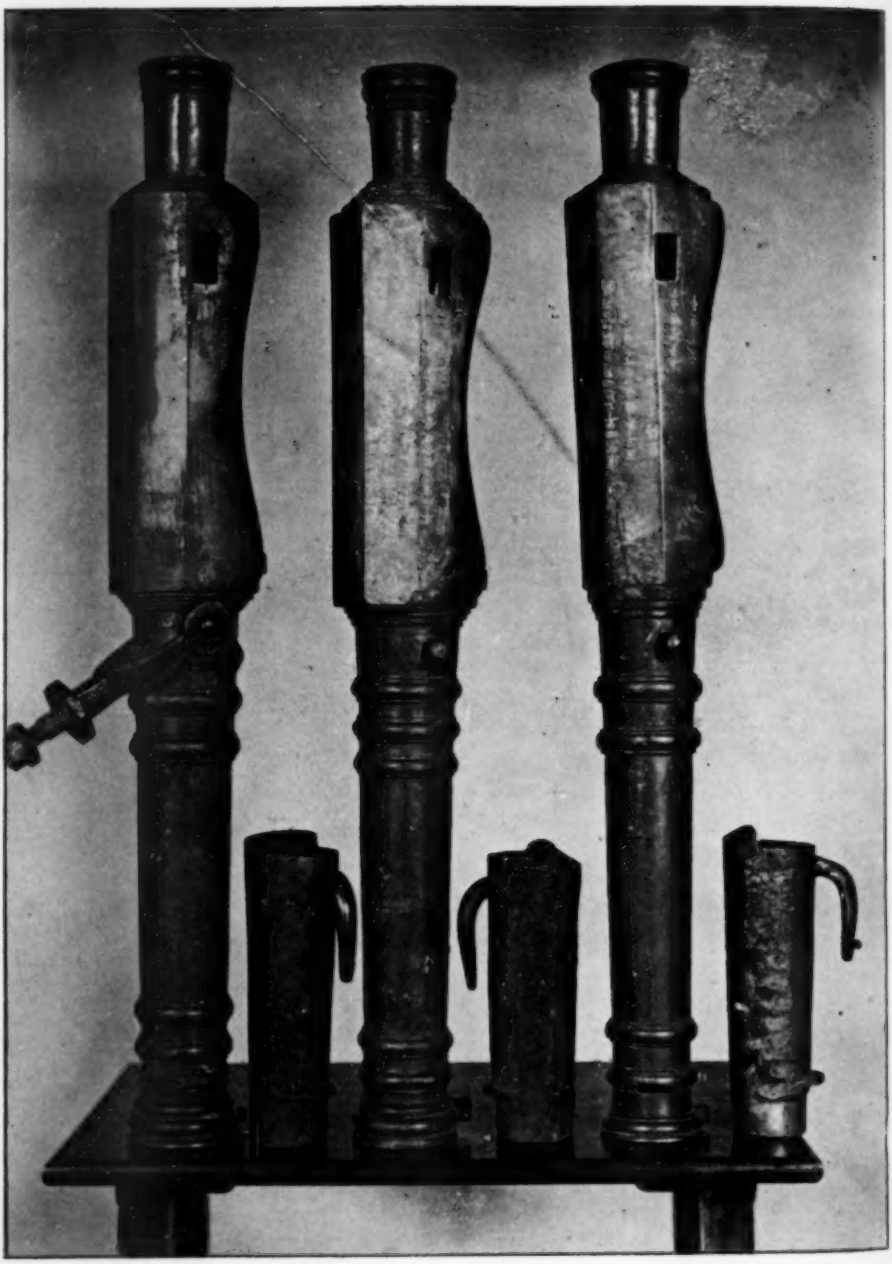
The range-finders will revive the era of citadels, central casemates and turrets. This follows from two facts incident to long-range actions. First, rapid-fire and machine guns will necessarily play a much less important part in long than in short ranges,—indeed, battles will be fought out of the range of the latter altogether; and second, the chance of obtaining a burst of a high-explosive shell between decks is materially decreased. The advantages of bringing the guns as close together as possible, thereby avoiding the inconveniences of supplying and controlling a widely separated battery, can once more be adopted.

In these days of high-speed ships, the captain who knows the range would have a decided and dangerous advantage over an opponent who was feeling for it; in fact, by skillful manœuvring he might draw much of his ammunition without injury to himself and at the same time be pouring in a well-directed and deliberate fire.

The effect of the range-finder upon the battle tactics of fleets will be to prevent mêlées; at least there will no longer be any cause for a rush and an entanglement of opposing ships, until one ship has been so disabled that her antagonist can rush on her and ram her. The action, as in the case of the duel, will be fought at long range and be decided by good gunnery. Rams and torpedo-boats will have their part to play, too, but instead of the attack opening with a dash of torpedo-boats, these with the rams will be held in reserve to give the *coup de main* to a badly wounded or disabled adversary.

These are some of the tactical changes and effects that it is thought the range-finder will work upon existing methods and ideas. But they are not all; every innovation is attended by consequences not seen at first, and doubtless when every ship in the service is supplied with one of these instruments, and "range-finding" takes its place in the regular routine of exercises, changes not thought of now and not anticipated will be gradually developed. In fact, a careful consideration of the subject by the writer for some months has suggested to

him consequences so sweeping and radical that he hesitates to express them all. He therefore submits this paper more as a tentative endeavor to open up a hitherto unexplored domain, than as a complete or finished essay, in the hope that the commanding importance of the subject will induce others to undertake its thorough and complete discussion.



NOTES ON THE DATE OF MANUFACTURE OF THE THREE GUNS AT THE U. S. NAVAL ACADEMY, CAPTURED IN COREA BY REAR-ADMIRAL JOHN RODGERS, U. S. N.

By Thomas Wm. Clarke.

One of these three guns is of a slightly ruder type than the other two. Both the others contain a mechanical feature which this ruder gun lacks, the ratchet on the under-side of the bottom of the boxing of the breech-cavity for engaging the point of an elevating pawl when in battery. A convenient mechanical contrivance like this could not have been introduced into ordnance and then omitted from professional work without providing a substitute, unless the traditions and models of former work had been lost.

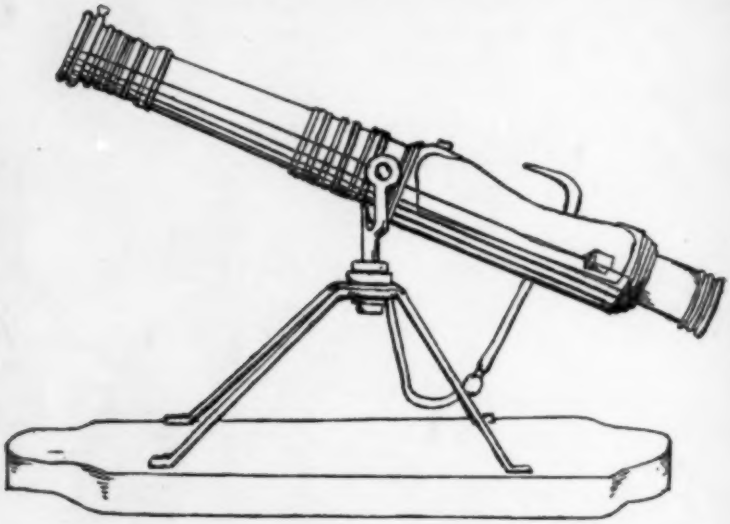
Chinese practice, still more than European, would respect the ancient and approved ways, and anybody would leave the better structure alone.

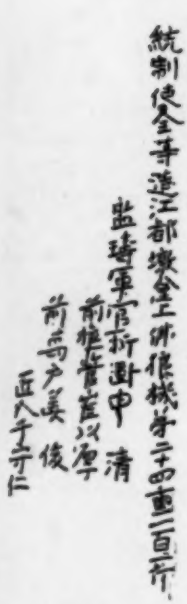
We may then, at this stage of the inquiry, and simply to settle the order of reading from latest to earliest, regard the gun without the ratchet as of earlier date than the guns with ratchets.

THE GUN OF 1680.*

All three guns bear inscriptions which have been translated by the accomplished scholar Wong-Chin-Foo, of New York. One of those with ratchets presents the longest inscription—55 characters. This reads:

* In the cut opposite, the left-hand gun, with swivel and nut, is the gun of 1680, the middle one is the gun of 1313, and the one on the right is the gun of 1665. The cartridge blocks are of cast iron and much honeycombed.





(Col. 1 at right) K'ang-Hi, 19 year 2 month day. (Col. 2) Tung-Chi-Shi whole company built *for* Kiang-do-dun *its* metal top, Fulang-khi number 24 weight one hundred and one catties. (Col. 3) Gien-Chi-Gwen-Gwan-Ja (The casting General, superintendent acting) Chung Shin Ching. (Col. 4) Chief managing official Chow-Yi-Ho. (Col. 5) General of division Kiang-Chun. (Col. 6) Master workman Yu-Shun-Jen.

K'ang-Hi was the regnal title employed by the second Emperor of the present dynasty. This title is indicated in this inscription as an imperial regnal title by having its first character slightly above the rest of the inscription; a curious etiquette which prevails in inscriptions, in proclamations, and in formal official documents, but not always in printed books. It is shown, however, in a page of a printed book which illustrates this article. There are now strict and arbitrary rules for this, going much further than mere elevations of single characters. The present etiquette requires full

spacing in the elevations. The present rules are recent and of this century. They are analogous to the black and red ink formalities of army papers in the United States.

This Emperor came to the throne in 1662, when eight years old. His nineteenth year would begin in February, 1680. He reigned over sixty years, and on his decease received the temple name of Shen-Tsu-Jen-Hwang-Ti, by which he is spoken of in books written after his death.

Father Adam Schaal, Chinese Missionary.

He was educated in part by Father Adam Schaal, a Jesuit missionary who had been his father's tutor, and who held, on the demise of the crown, official position in the board of mathematicians.

Under the regency which ensued, and which lasted about four years, there was a religious, perhaps a national reaction. The missionaries fell into disgrace and were imprisoned, but were released and restored to favor in or soon after A. D. 1666, when the Emperor began to govern as well as to reign.

For a century and a half the one undisputed Chinese fact among Europeans has been, that at this period the autochthonous skill of the Chinaman in ordnance and artillery was very limited, if not quite lacking. Nothing less than most convincing proofs can shake this conclusion. This proof is at Annapolis.

Father Duhalde relates that there were during his residence in China, somewhat later than this date, some bombards at the gates of Nanking and some "Pattereroes" in the buildings on the sea-coast, but not skill enough in China to make use of them. In 1621 the city of Macao gave the emperor, Tien-Ki, three guns; to manage which, Portuguese engineers were taken into Chinese service. These Macao guns proved terrifying to Tartars, so that in A. D. 1636, under the last Ming Emperor, during the Tartar invasion, at a time when there was a persecution of Christians for the purification of the empire, and to appease the divine wrath, Father Schaal was entrapped into admitting that he knew the European method of casting guns, and was ordered by the Emperor, Tsung Cheng, to instruct workmen in the art, and was assigned a proper place near the palace and allowed assistants from the imperial retinue.

Father Ferdinando Verbiest. Chinese Missionary.

Though not directly stated by contemporary European writers, it is believed by Williams and others that some guns were produced by Father Schaal. Duhalde says: "Use was made of this Means to introduce into the Empire a great number of Evangelical Workmen." Whatever was inaugurated by Father Schaal was but temporary, and his laboratory, if any was formed, had been broken up before 1670.

In 1665, Fathers Schaal and Verbiest were imprisoned in fetters, and Father Schaal was tried for his life and convicted, but he was released, pardoned, and died of a good old age, August 15, 1666.

While in prison, a controversy arose as to the accuracy of the official almanac, and the Jesuits, excepting Father Schaal, were taken out of prison, brought before the Emperor, and ordered to make a series of instrumental tests of the accuracy of its calculations. The date of this is not given, but it must have been before August, 1666. On proving the error of the official astronomers, Verbiest was ordered to find out the errors and correct the work, and another series of observations was made, the result of which was that in A. D. 1669 Father Verbiest became President of the Board of Mathematics. After this he caused to be made several altitude, azimuth, equinoctial and other measuring instruments, quadrants, sextants, and a celestial globe of great weight and size, from cast brass, with fine modeling and with very decorative features in the Chinese style.

After this work had been done, its mechanical excellence attracted the attention of the Board of War, probably about 1678, because about that time he finished his work on the calendar and presented his book of calculations to the Emperor, and was promoted in rank and awarded a title.

The Board of War obtained an order on Verbiest to instruct workmen in the art of cannon-casting, and "he cast 130 pieces with great success."

After this the Board obtained another order on Verbiest, by his Chinese title of Nan-hoai-jin, given him in 1678, ordering the casting of 320 pieces of various calibers and of the European fashion, and that he should oversee the work. On February 11, 1681, he delivered the models, which were approved, and the Board of Works was ordered to furnish all that was necessary for the work. The job took over a year. Many difficulties were encountered, attributed to the jealousy of courtiers. One of these troubles enables us to say that these guns were muzzle-loaders. An attempt was made to disable a gun by wedging a shot in the bore. Father Verbiest removed it by the now well-known scheme of loading with powder at the touch-hole and firing out the shot. All of Verbiest's guns were blessed and engraved with saints' names in the foundery, and were engraved with proper characters traced by the Father's own hand.

The proof of these guns was made in 1682, and twenty-three thousand practice-shots were fired from them. Father Verbiest was

again promoted in official rank to a position equivalent to that of "Viceroys who have deserved well in their government."

On this occasion the Emperor said to Father Verbiest, "The cannons that you made the last year were very serviceable against the rebels, and I am well satisfied with your services," and he gave the Father his furred vest and gown.

KANG HI.

This dates Father Verbiest's gun-founding work in A. D. 1680 to 1682. It was done in Verbiest's own foundery near the palace. It was muzzle-loading work, and was marked with saints' names.

Neither of our three breech-loaders is so marked, hence neither can be a Jesuit gun of Verbiest's time. They present a special variety of the familiar type of *pedrero*, of which the Cortes gun now at Annapolis, made probably as early as 1474, is another variety. They are what is called by the English writers of the Tudor and Stuart and early Georgian periods "petereroes," a word which is spelt with a great variety of combinations of t's, e's, r's and a's. Such swivels were familiar to Europeans in the sixteenth and seventeenth centuries, as shown by the numerous illustrations of them collected by Favé for the late Emperor Napoleon's work on Artillery. Duhalde does not claim that they were introduced by the missionaries, but on the contrary concedes them to have had a more ancient origin.*

* As Duhalde is not divided into numbered chapters, and as there are several editions, some in two and some in four volumes, and of various dimensions of page, it has not been practicable to refer to this authority at each citation, but a compilation of the dates given in the section on "Cang Hi," in the chapters on "Military Government," etc., "Of the Nobility," and "Of their Astronomy," shows that the dates given above are substantially accurate. The copy consulted was Brookes' translation, 3d edition, London, 1741, 4 vols. 12mo.

Duhalde also in his chapter on the History of Corea relates that in the 26th year of Wan-Li (A. D. 1598) the Chinese commander had a cannon shot off as a signal for springing a treacherous ambuscade contrived against the Japanese general, Hing-Chang. Griffis' "Mikado's Empire," p. 246, speaks of a breech-loading Japanese cannon of this period — the Japanese invasion of Corea — still preserved at Kioto. Even earlier than this, one of the generals in Corea had his horse killed by a "canon shot."

We are now prepared to analyze this inscription. The gun was made about March, 1680, for the Chinese year began in February. Its destination was the metal top of the fort (Dun) at Kiang-Tu (the river capital). It will not be too hazardous a conjecture to say this was a barbette battery at Ngan Kiang Fu, now capital of Ngan-Hwei, then the western capital of Kiang-Nan. There was a large garrison there, a strong and notable fort, and the times required this point to be vigorously maintained. Twice before in the history of China had the control of Poyang Lake and of the river-bend close by seemed decisive of the fate of a dynasty,—when the Mongols obtained and when they lost the empire. In 1680, to the south and southwest of this pass, the organized armies of a Chinese revolted vassal who had assumed the yellow vestments were in full force and concentration, and the Tartar generals had got control of the sea-coast and were pushing inland along the southern frontier towards Yunnan, in order to isolate the revolt in an uncultivated mining country, where lack of supplies would in the end compel the rebel chief to risk an engagement on the field of his adversaries' choice or lose his army by famine or desertion. The fort at the Poyang Lake pass is a likely, but not certain, original destination of this piece.

The personages who were responsible for the enterprise were Tung Chi Shi Tsien Zhe. The last two characters clearly signify the whole body or company. Shi is a character which implies civil magistracy. Tung Chi is to-day, as Mr. Mayers' manual of Chinese Governmental Titles informs us, the colloquial designation of the chief military officer of a single province or the second military officer of a viceroyalty. The second column can then be paraphrased in English thus: "The provincial general-in-chief and the whole body of civil magistrates (of the western government of Kiang Nan) built (for) the barbette battery at Ngan-Kiang-Fu, Fulangkhi Number 24, weight one hundred and one catties."

The next notable thing is the height of the succeeding columns.

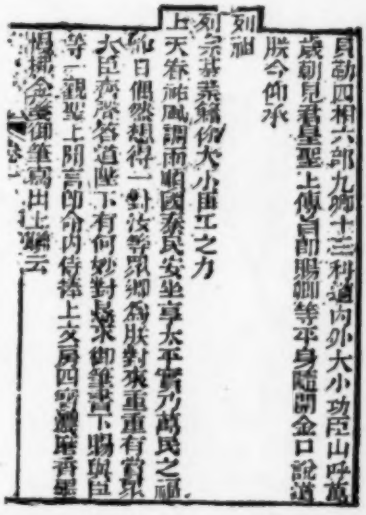
The third column begins abreast of the seventh character of the second. The fourth and fifth begin abreast of the eleventh character of the second column and the fourth of the third. The third, fourth and fifth columns end about even. The sixth has its top two characters lower down than the top of the fifth column and ends a character lower. These are signatory columns, and show that one functionary was of considerably higher rank than all the others, and one of considerably lower rank.

The workman who practically did the work was Ju-Shun-Jen (Col. 6). The principal supervisor was a military mandarin, acting as superintendent, named Chung-Shen-Ching (Col. 3). The next in authority was a Tseng-Twan-Gwan (chief managing magistrate). He was probably subordinate to the Board of Works and may be called the principal director, Chow-Yi-Ho (Col. 4). The third inspector was entitled Tseng-Wan-Hu, and was named Kiang-Zin. This title translates chief of 10,000 families. One must not, however, in Chinese, any more than in English, over-analyze syllabic constituents of a word or phrase. By itself the word "sloop" signifies a fore-and-aft rigged vessel with one mast and a bowsprit, which has her head-sail in one piece, with its tack made fast to the outer end of the bowsprit. "Sloop-of-war" designates a vessel which has none of these characteristics. The English Major-General corresponds to the French General of Brigade. The American Major-General corresponds to the French General of Division. In gunnery we find mentioned in English about a century ago "murderers" and "murdering pieces," as well as "petereroes." They refer to the same sort of gun, a light swivel. Just as the French *perrier* and the Spanish *pedrero* have lost their relation with stone shot and now signify only the swivel mounting of the piece, so the coupling by the Spaniard of a pair of swivels into the masculine and feminine or fatherly and motherly relation of *padrero* and *madrero* (motherling or pet) gave Jack Barnacle a chance to convert a Spanish jest into an English special noun of appropriate sense for its retained sound, and Diego's mother's darling was transformed, by the English mouth struggling with a Spanish word, into a truculent assassin.

Thus, while the title Wan-Hu recalls the Mongol national organization on a plan of decimal family groups, which forms the basis of the early Hussar or hundredth-man levy of Hungary, and of the Cossack contingent of Russia of to-day, so the families which averaged a soldier apiece have ceased in this title to be an exact description,

the myriad has become numerically vague, and the Wan-Hu chief signifies in a society, which has passed from the nomad to the sedentary stage of civilization, such a military officer as would command a force equal to that furnished by 10,000 nomad families. It will not be unsafe to consider this title as that of a Tartar General of Division, or chief of a banner.

This gun is number 24, and its weight is 101 catties (about 135 pounds). The sort of weapon is Fulangkhi. Fulang is now used colloquially to designate the French. It is also used for foreigners generally, as Frank has been used in the Levant for centuries. The selection of characters to form this word would always suggest to the educated Chinaman the ideas of barbarian, spadassin, and beast, while the syllable *Khi* is so formed as to suggest manufacture, well contrived and weapon.



PAGE OF BOOK TO ILLUSTRATE ELEVATION OF CHARACTERS.
(See p. 266.)

When the reign K'ang Hi began, the boy Emperor had by no means a well-established throne, far less a prospect of the grandeur and power which he attained. While his court exercised direct sway over part of the provinces north of the Yang-tzee and over one or two south of that river, three Chinese vassal-kings, who owed him little more than homage for investiture, maintained large independent armies, held most of the provinces south of the Yang-tzee and west of the Yellow river, and controlled the tea crop, most of the silk crop, a large part of the rice crop, and all the foreign commerce. Each was only less powerful than the Emperor. The three, and probably either two — the other neutral—could overmatch him. The famous Cheng-Chang-Kung was established at Formosa as a sea king, and ravaged the coasts of the imperial provinces so that they were depopulated for three leagues inland and the sea fishery broken up. The Emperor's court was seamed with gentile and sectarian dissensions. The calendar was disgracefully erroneous,

and was proved so in 1666 in the presence of the Emperor, with improvised instruments got up over night by men just out of prison. After four years of regency this boy of twelve dismissed his tutors and guardians and took the scepter himself.

He had been born to good luck. The great Formosa prince had died the year of K'ang Hi's accession. Cheng King-Mai, with less warlike tastes than his father, kept the peace of the sea for ten years.

In 1673 an attempt was made to organize a great gentile movement of China for the Chinese. Wu-San-Gwei, who had a powerful army trained in civil war and fresh from the conquest of a secure frontier on the side of Burmah, put himself at the head of it. He was the most powerful of the vassal-kings and assumed some of the imperial functions. Keng-Tsing-Chung, who had just succeeded his father in Fokien, and Shang-Ko-Ho of Kwang-Tung, the other two vassal-kings, were in the combination, and Cheng-King-Mai sailed to join his forces with those of Fokien, of which he was a born subject. Wu-San-Gwei promptly invaded and occupied the imperial provinces near him. A few questions of etiquette spoiled the combination. The conspirators had not agreed in advance about the yellow vestments or their own respective precedency. Cheng-King-Mai failed to be received at Fokien as an equal and independent prince. Shang-Ko-Ho of Kwang-Tung preferred a vassalage which had known limits to an undefined and vague future, and refused to change his allegiance prematurely.

Wu-San-Gwai AD 1643 to 1668.
from a Chinese print

The Prince of Formosa, stung by the affront to the past of his family, by force of arms drove Keng-Tsing-Chung to submit to the Tartar and then retired to his island to sulk and die. The armies of Kwang-Tung and of Fokien were soon arrayed under imperial

generals against the Prince of Western Peace, and that aged Chinese patriot died in 1679. Two years later the rebellion was entirely suppressed. The son of Wu-San-Gwei, who had been proclaimed Emperor, committed suicide. Shang-Chi-Sin, who had succeeded his father on the latter's suicide in 1676, in 1680 received the imperial sentence of death, which was mitigated by the imperial present of a red silk cord and a sign-manual permitting suicide, for thus his royalty was acknowledged while his treason was punished. He obeyed the sentence and hanged himself in red silk like a king. Keng-Tsing-Chung, of Fokien, who had been too strong to punish in 1674 when the dynasty was in danger, was executed with ignominy in 1681 and his brothers were beheaded. Conflicting ambitions had swamped a conspiracy which if combined had been stronger than the empire.

From this date on, to the end of his almost unequaled reign of sixty years in 1722, the Emperor showed himself a vigorous, enterprising and intelligent prince. He was athletic in person and proud of his strength and skill as an archer. He was a bold huntsman and did not hesitate to encounter the tiger with sword and spear. He studied and promoted the arts and sciences. He was versed in the literature of his empire, and personally and almost daily supervised the compilation of the great Chinese dictionary, a work unrivaled in western nations till the publication of the encyclopedic dictionaries of the present day. He instituted an elaborate topographical survey of the empire, and caused to be collected statistics of its resources and requirements. He re-established, revised and regulated a system of posts, post-roads and signal-stations for visual telegraphy, managed by squads of soldiers always on duty. He repelled from the borders of the empire the dangerous tribes of barbarians, and established the bounds and limits of the nomads across the frontier, so that friendly clans and tribes attached to the fortunes of China by similarity of race, by family relations, by social rites, by ties of hospitality, and by the ambition or interests of chiefs, should range along the boundary and the jealous and ill-disposed be kept at a distance. Corea, Tonquin and Annam sent him tribute. Thibet yielded to his arms and received his frontier garrisons. He negotiated with foreign powers, had treaty relations with Holland, Russia, Portugal and the Pope, and had a correspondence with France. He pacified the empire, readjusted the boundaries of the provinces, and fixed the present administrative system with its all-pervading dual

executive staff of functionaries of the dominant and subordinate races. His manners were popular, affable and dignified. He was an economist and an able financier. He utilized the army in the postal service, as a rural and municipal police, as exterminators of beasts of prey, as gatherers of the products of the deserts and the forests, and made the soldiers cultivate on military reservations some part of their subsistence. He paid great attention to justice. Most of this great work was done later than 1681.

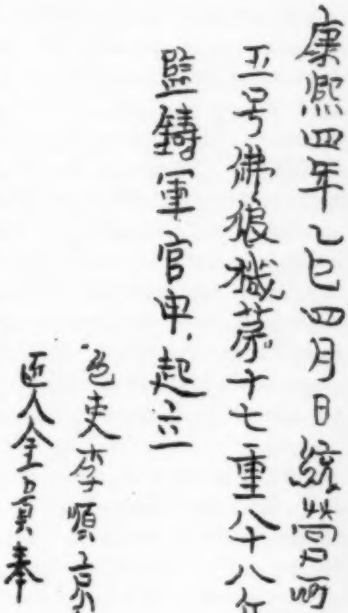
We have seen from the dates that it was almost impossible that Father Verbiest should have made this gun of 1680, but that if he did it was of the first lot of 130. Doubt can only arise from the very explicit statement of the Jesuit fathers that the Board of War sought the aid of the fathers for instruction in the art, as if they were ignorant of it.

Of what were the Chinese ignorant? Certainly not of the art of moulding, melting and pouring copper alloys, for under the Emperor Yung Loh, nearly three centuries before, five great bells had been cast which weighed 120,000 pounds each. Marvellous bronze vases of great size and great bronze lions are spoken of in contemporary works of missionaries who make no mention of any metallurgy of copper save that derived from Europeans. But the plunder of the Summer Palace, with its dated masterpieces, has long convinced Europe that the bronze founder of China has been possessed of great technical skill from generation to generation for about a thousand years. The only things they needed to learn were the shapes to be moulded and the alloy required.

Europeans worked at random in the metallurgy of bronze till the present century, using old metal without quantitative assay or analysis for a large part of their material, and their proportions of copper in guns varies from 75 to 88 per cent, of tin from 7 to 15, of zinc from 5 to 15, and there were usually traces of iron and a notable trace or percentage of lead. The definite mixture of the present century had no place in the arts of Europe before 1800. The Chinese knew the crucible as well as any. They needed most of all a pattern-maker, a designer of new forms of artillery. This they found in Father Verbiest. He did not make breech-loaders.

THE GUN OF 1665.

Let us now turn to the other gun with a ratchet, and see if the gun first under consideration was of the European model introduced by the missionaries.



The inscription reads: K'ang Hi, fourth year Yih Chi, fourth month (*lacuna*) day Tung Ying So cast. (Col. 2) Fifth class Fulangkhi, number 19, weight eighty-eight catties. (Col. 3) Gien-Chi-Gwen-Gwan (casting superintendent general) Shen-Khi-lik. (Col. 4) District Magistrate Li-Shun-Jing. (Col. 5) Master workman Kin-Ngai-Bong.

We have here a different formula. The date is May, A. D. 1665, which is determined by the regnal year, fourth,—1662 being the first,—and also by the cyclical words Yih Chi, which denote the forty-second year of the cycle of sixty then current, of which 1624 was the first year.

At this date, 1665, we are explicitly told by Duhalde, the persecution of the missionaries was at its height. Father Schaall was in prison and was soon afterwards sentenced to death. Father Verbiest and two others were also in prison "loaded with nine chains." This work then, made before Father Verbiest did any bronze casting at all, five years before he cast his first lot of guns, and six years before he delivered his perfected patterns to the Emperor, owes nothing of its technique to him.

The contribution of Father Schaal in and after 1636 to the defensive strength of China is nowhere definitely stated. It is said that the order to do the work was the occasion of importing "evangelical workmen" or missionaries. Father Verbiest's practical results are enumerated, and he was arraigned before Christendom for violating a canon of the Church which forbids Christians to aid infidels in war, and defended himself with the argument that the infidels aided were warring with infidels, and the work done enabled the Christians to attain among these infidels a footing otherwise impossible. No such arraignment of Father Schaall was made, no specification of any but the evangelical results of his work is found. He is not cited as a precedent by Verbiest.

Schaal's work in the last years of the Ming dynasty was, therefore, without consequence in the ordnance department of China.

Yet in 1665, when he was in prison, we find five classes of "Fulang-khi" in use, we find them cast in the presence of local magistrates, and we find a department in charge of the work.

Kin-Ngai-Bong was the artisan, Li-Shun-Jing was the local magistrate, and Shen-Khi-Lik was the Gien-Chi-Gwen-Gwan, not "acting" as was in 1680 Chung Shen Ching, but the regular officer. He was a Gwen or military mandarin. The board, however, which did the work was not the Tung Che Shi Tsien Zhe of 1680, the high provincial magistracy, but was the Tung-Ying-So. "Ying" signifies a battalion or division; "So" is an office, chamber or station which performs or forwards government business. It is also a station on the canal. Ying always implies an officialism which has to do with troops. In the title Ying-Ping-Han, conferred about B. C. 60 on Chao-Chung-Kwoh, and rendered the Marquis Organizer of Peace, this character Ying certainly refers to the military system which makes peace permanent. The French-drilled division of guards of to-day is the Shen-Ki Ying.

The force of the character "Tung" seems always to be that of high military designated or assigned duty in a capacity less than that of command in chief but greater than that of executing orders given in detail. One cannot say it always implies provincial authority. But if it does not, it implies connection with the Board of War. As good a translation of this part as can now be suggested is "Bureau of the select battalions," that is, selected soldiers for ordnance and artillery work. The "arsenal" is a good rendering.

The fact is now plain that the "petereroes in their buildings on the coast," spoken of by Duhalde, were a sort of gun which the Chinese knew well how to make as early as 1665, and called them Fulangkhi. These petereroes had been systematically classified, and those of the fifth size weighed rather less than a hundred and twenty pounds ($88 \times 1.33 = 117.33$).

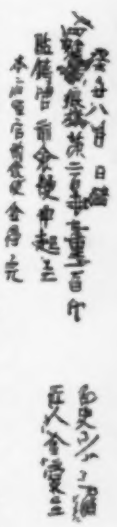
For the model or metallurgy of the Fulangkhi or light breech-loading swivel, the Chinamen were not indebted to the Jesuit fathers, but this sort of gun was older than any gun-founding for which they were responsible either as instructors or superintendents, and was of a different class from any recorded to have been done by them, all theirs being muzzle-loading work.

Duhalde complains that Verbiest was treated unfairly, that he was

chidden for delays, that the metal was stolen, and that attempts were made to disable the guns. One can hardly take these complaints seriously, they so betray the writer's ignorance of business. Of course the inspectors wanted to show that muzzle-loading guns were not as good as breech-loaders and tried to disable one of them. Of course the metal fell short. It always does, unless the melting is twice the weight of the finished article, and a wastage of ten per cent on a melting is not unusual. As late as the beginning of this century the natural deterioration and loss of metal in making the incrustation of the column Vendome caused the temporary disgrace and nearly caused the professional ruin of a French artillerist. Nothing but the discoveries of the great chemists of the time saved a very honest man from indictment as a swindler and fraud because of the natural deterioration and waste of bronze and brass in recasting.

THE GUN OF 1313.

The third gun of this Corean capture has a sturdiness of modeling which may indicate an earlier date of manufacture. The lack of the ratchet for the elevating pawl strengthens this conclusion. This gun bears a six-column inscription, the characters of which are evidently cut with a graver, and are of a shape said by a competent critic to be of ancient style.



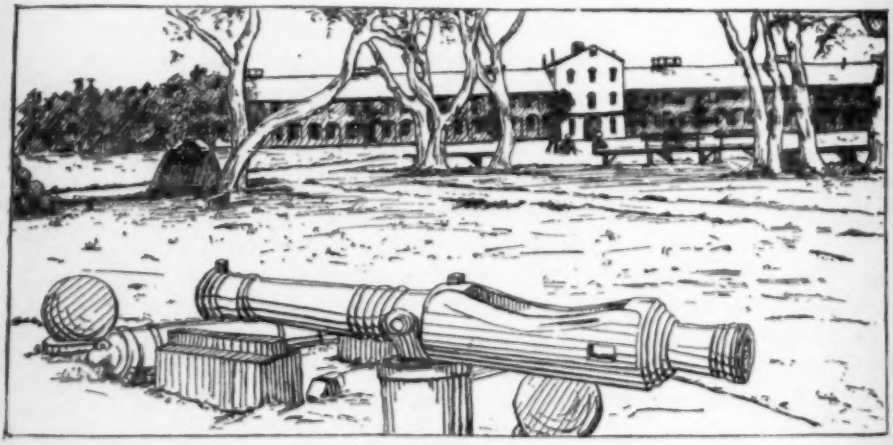
Two characters of the Hia Tse series (cycle of sixty) date it in the Kwei Chow, or fiftieth year of the cycle. It has no regnal title at the head of the date-column. Hence, although the absolute place of the date in some cycle is clear, the determination of the relative position of this year in any chronology requires a marshaling of evidence.

The inscription reads: (Col. 1) Kwei Chow, 8 month day, made cast. (Col. 2) 4 class Fulangkhi number two hundred twenty-nine, weight one hundred catties. (Col. 3) Make cast superintendent Tseng-Tsien Shi (Chief Assistant Privy Councillor) Shen Khi Lik. (Col. 4) Pen Fu Gwen Gwan (General of Ordnance superintending), Chief Assistant Privy Councillor Kin Tack Yuan. (Col. 5) District Magistrate Sung Si Lien. (Col. 6) Master Workman Kin Gai Lik.

The first notable thing about this inscription is that there is no regnal title at the head of the date-column,

and that the date-column is one character shorter than the next adjacent column on its left. If this were done for a reason and we knew why, it might assist in dating the piece.

At Fort Monroe there is a gun from this same Corean capture of this same size and shape which carries an incised inscription in six columns, the characters of which are of the same general style as those on the gun at Annapolis. The first, third, fifth and sixth columns contain respectively the same characters as the corresponding columns on the Annapolis piece; the second column differs only in the number of the piece, 194. The fourth is devoted to some sort of functionary, the "Pen Fu Gwen Gwan," and to the same "Kin Tack Yuan" as before, but his rank in the empire differs. When the Fort Monroe gun was made he was a Tseng Wan Hu. When the Annapolis gun was made he was a Tseng-Tsien She.



FORT MONROE GUN.

The characters Kwei Chow, which begin the date-column, are in the Fort Monroe gun, as in that at Annapolis, a character below the head of the next adjacent column on the left.

There can be no doubt that these two contemporaneous records of identical formulæ, which mention four different men in four different responsible positions, three of them, as the old English phrase goes, places of worship, two of them ranking as Assistants to the Privy Council, memorizes a time when there was an organized gun manufacture producing thirty-five guns or more a month. Kin Tack Yuan, one of the managing officers, was promoted during the month.

The fact that both guns lack the regnal title shows that it was omitted purposely. The fact that the date-columns are shortened by one character at the top shows an intent to fill them afterwards.

It will not be worth our while to search for this Kwei Chow year earlier than the crusade of St. Louis nor later than the epoch K'ang Hi. Within these limits the eighth month of a Kwei Chow year might fall about September in any of the years A. D. 1253, 1313, 1373, 1433, 1493, 1553, 1613, 1673.

The inference is unavoidable, however, from the structure of these date-columns, that while the same foundery was at work under the same superintendency casting at the rate of thirty-five small guns a month of successive numbers, melting two or three tons of brass each month, and about the beginning of the eighth month of the year, some event happened which rendered the engraver doubtful about the regnal title, and caused him to leave a blank in this part of the inscription, to be filled when the doubt was solved.

Such a doubt could only arise on an impending change of regnal title. If, therefore, we can find some Kwei Chow years after the institution of the Pen Fu office in which, in the eighth month, a change of regnal title was impending, we shall have an indication to assist us to the exact cycle of sixty to which these two guns belong.

An emperor of China is nameless during his reign. After his death his family confer a title by which he is inscribed in the ancestral temple and by which historians may speak of him. Usually this name is not one which has been associated with him in his lifetime. An emperor is spoken about in his lifetime by various titles, such as Son of Heaven, Autocrat, Dragon's Throne, and he refers to himself as The Solitary, or by some epithet deprecating divine visitation.

Every emperor, however, on ascending the throne, decrees the phrase by which the epoch of his reign shall be known till further orders, and determines whether this epoch shall begin at once or in the future.

Usually the new epoch begins on the next New Year's Day. This epochal phrase continues in use with the years numbered in series under it till a new epochal name is adopted. That may go in use at once or at a later day, usually New Year, and the years of the new epoch are numbered in series beginning again at one. Some rulers have had great versatility in these regnal titles, using three or four in some years, and averaging one a year for ten or fifteen years, as for example the Empress Wu-How. Others kept the same regnal

title Kang-Hi, or Kien Long, for sixty years. If, therefore, a change of regnal title took place in the last part of a Kwei Chow year, or at the beginning of the next year, while the Pen Fu office was active, it would be a pregnant indication.

In A. D. 894, the year succeeding a Kwei Chow year, the Emperor Chow Chao Jung changed his regnal title, King Teh, to Kien Ming.

In A. D. 953 an emperor died, and his successor proclaimed his regnal title as Hien Teh, to take effect on New Year's Day, 954.

In A. D. 1074, on New Year's Day, the Emperor Liao Tao Jung (a sort of side-show emperor of an intrusive house) changed his regnal title from Hien Yung to Ta Kang.

In A. D. 1314, on New Year's Day, the Emperor Jen Tsung of the Yuan dynasty changed his regnal title from Hwang King to Yen Yew.

No other change of regnal title was made in a Kwei Chow year, or a year next succeeding a Kwei Chow year, from A. D. 1314 till now.

Unless, then, it is absolutely incompatible with other indications, the second year Hwang King (A. D. 1313) is probably the Kwei Chow year in question.

To satisfy this or any other assumed date of manufacture four other things must concur. There must have been a Pen Fu department at the time, and in that department two officers of the rank of Tsien Shi and one of the rank of Wan-Hu. If these officers or the department did not exist in any of the Kwei Chow years, such years would be excluded from consideration.

The late Chinese Minister at Washington, Mr. Chang Yin Hoon, at request of Secretary Bayard translated the Fort Monroe inscription, and with a politeness characteristic of his nation declared to the Secretary that he was "grateful for being permitted to *share* in the pleasure of perusing the curious inscription." To his research is due the discovery of an ancient ordnance department and its organization. His communication could not be published without violating the customs of diplomacy and the rights of authorship, and yet a paper on this subject which did not accord to him the credit of the discovery would fail in honesty as much as it would in politeness or gratitude. To him, therefore, in consequence of this discovery, the following argument owes its fundamental fact, and so most of its force.

The great emperor of the Mongol dynasty, Kublai Khan, then employing the ruling title of Che Yuan, in the eleventh year of that part of his reign (A. D. 1274) established a department for the con-

trol of gunners. The siege of Siang Yang Fu, when he is said to have taken Western engineers into his service, was then pending.

Eleven years later (22d year of Che Yuan) he reorganized the department (A. D. 1284). At the head of it was a Ta-su-ko-shi. It had a Wan-Hu and a vice-Wan-Hu. Attached to it were two Privy Councillors, Shu-Mih-Yuan or Shu-Mih-Shi, and two assistants, Tsien Yuan or Tsien Shi.

Abbé Grosier in his "Description Générale de la Chine," Paris, 1795, relates that Kublai's armies under Sotou had in the year 1283 been repulsed in Cochin China by the "Mahommedan cannon" of the Annamese. Late in 1281 the Japanese expedition had been destroyed after lying off the shores of Japan for weeks unable to effect a landing. It is perhaps fairly doubtful whether the fleet carried guns, but Griffis, in the "Mikado's Empire," gives an engraving from a Japanese picture of the repulse of the Mongols which represents junks in the offing wreathed in cannon-smoke.

KUBLAI, FROM YULE'S MARCO POLO.

The title Pen Fu implies personal imperial relations and is very nearly equivalent to Ministry of the Household. Privy Councillors and Assessors of the Privy Council, as officials, indicate importance, and a Wan Hu, as a subordinate, also indicates this. A Wan Hu at this time must be taken as equivalent to the chief of a banner of Mongols.

Such a bureau so elaborately organized would not fall into decay in the six years which elapsed before the death of Kublai, nor in the twenty years from Kublai's death to Jen Tsung's accession.

Our Kwei Chow year of 1313 occurs at a period when every

criterion is satisfied. There is in the State a Pen Fu department with its two Assessors of the Privy Council, and Wan Hu as officials, and there was, near the close of the year, an impending change of regnal title which was a sufficient reason for leaving a blank for the two missing characters. One might well doubt if he was in the epoch called Hwang King or in that called Yen Yew, if the change had been determined on. To prepare and print the calendar for distribution on the first of the tenth month, two months' time for drawing every page, for cutting the blocks, for printing, binding and assorting for delivery many thousand copies, is not too much time, and this carries us back to the eighth month as a necessary time for determining the text of the new phrase.

Previous Kwei Chow years are already excluded by the lack of the bureau and its officers. Later years will not furnish the reason for a blank. But if they also lack the ordnance office of the Mongols, the date of 1313 will become certain.

Kublai, grandson of Zingkis, and First Emperor of Yuan Dynasty.

Before taking up the direct evidence on this point let us consider a little the state of China when the Mongols obtained and while they held and when they lost the throne.

For over two hundred years before the time of Kublai there had been two bitterly antagonistic emperors in China, and for the thousand years before, it was only at intervals that any ruler pretended to exercise more than a tax-taking jurisdiction over this vast territory. Some attempts at imperial legislation had been made. Some efforts, by establishing inspection circuits, had been had at uniformity of administration and regularity of justice. But China was not yet a nation such as England has been since the days of Edward III.; such as France became through the seismic politics of the Revolution, the Empire and the Restoration; such as Japan became on the restoration

of the Mikado; such as America is since the experience of the Civil War.

Zenghis had marched to its conquest early in the century, when it comprised two sovereignties, the Sung, which ruled south of the Yang Tsee Kiang, and the Kin, which ruled the northern provinces. The Kins were intrusive Tartars. The two kingdoms were normally at war from the policy of the Kins, and the boundary between them was defined rather by present prowess than by monuments or treaties respected by both sides. An attempt to introduce a militia system in the Sung empire at the close of the eleventh century had strained the sinews of loyalty and shaken the imperial throne. The Sungs encouraged the Mongol war upon the Kins for the sake of present rest.

As general for his uncles and for his own brother, Kublai, before he became emperor, had reduced the remote western and southern provinces of the Sung empire without more resistance than could be offered by the levies of local authorities, and without stimulating the Sung emperor to great warlike preparations.

The Mongols, bred for ages to a nomad and pastoral life, dwellers in tents, hunters and warriors, united by families into clans, tribes, hordes or banners, and into a confederacy of greater or less strength according to the ability of the leader, were always a migrating nation. They took what they needed and passed on. They enslaved their prisoners, and promoted their slaves by adoption. The national organization was merely military. The national revenue was plunder. Sharing the loot paid the soldier and his officer. They swept a country clean as they went through it. Kublai's military system and that of his generals was to enter a province, summon the towns, take possession of the provincial government, receive the attornment of the authorities, disband the local army, put a Mongol detachment with a Mongol leader in charge, and move on. The disbanded soldiery generally incorporated themselves with the moving army, because the Sung system had been to consider a soldier as a bandit hired on the side of lawful authority instead of arrayed against it.

Recalled from his southern expedition to assume the throne, Kublai left his general Pe-yen to practice the same policy, and himself led the northern army to the conquest of the province of Houquang. Siang Yang Fu was taken after a five years' siege, and subsequent operations gave Kublai control of the Yang-tsee above Nanking. The Sung emperor had left only the provinces of Che-Kiang,

Fokien and Kwang-tong, all on the sea-coast, all self-supporting, all populous, and all of them commercial and industrial as well as agricultural. Again Kublai attacked in detail, sending Peyen into Fokien and going himself to Che-Kiang. Six years more of war against three baby-emperors ended the struggle. But if, after the complete conquest of the Kins, it had taken twenty years to subdue the southern empire, where there was so little national spirit and no large mutual helpfulness, so that the invader could take it province by province as he would eat an artichoke, leaf by leaf—the simile is Caesar Borgia's—what could he have done against a China as united, as single in purpose, as patriotically devoted to its emperor as the Mongols were?

His imported Mongolian alloy was perhaps one or two per cent of the population, certainly not more. He could not breed a nation in many generations. He must educate one. He established a provincial system directly dependent on the central power at Peking. He united the north and the south by the greatest of engineering works of that and, till recently, perhaps of any day,—the great canal. He tried to secure public confidence by giving his administrative and judicial offices to natives of Chinese race, while he kept the purse and the sword in the hands of Tartars, or, in some few instances, of devoted foreigners. He was lavish in succoring popular distress. He adapted his methods to Chinese customs, and celebrated all the Chinese worships with a catholic or indifferent spirit quite paralleled by the policy of Henry of France when he thought "the good city of Paris was worth a mass."

The roads, the bridges, the system of post-houses and of scattered military posts a league or so apart along the highways and canals, doing the duty of messengers, signal men and rural police; the public granaries, which sold the tribute corn in times of dearth at moderate price; the slack-water navigation inaugurated or enlarged and maintained by Kublai, all kept in full view of the people and paid for by the public revenue, show his centralizing policy, his determination that in his conquest at least there should be no question who was the head of the State.

Artillery, for a hundred years after it was introduced into European war, was a special profession quite distinct from soldiery. The professional artillerist was gun and bullet founder, powder-maker and combatant. The profession first became truly military under Louis XIV., and it is only within a hundred years that artillery-drivers have

been enlisted men. Kublai, in the interests of his centralization, nationalized the profession as a branch of his household ministry.

Jen Tsung, when he came to the throne, resolved to open the career of native talent still wider. He ordered the Sung history to be compiled as a concession to Chinese glory, and entrusted the service to Chinese. He instituted more rigid examinations in the civil service, and removed from the lists many officials who could not pass the new ordeal. He appointed men of Chinese race to places of power as well as of responsibility. He found the centralized provincial policy of Kublai unpopular, and modified it in the interests of local authority. His successors still further relaxed the control of the capital. Yet in 1355, under Shunti, the last Yuan emperor, a preponderant Mongol officialism was one of the great complaints.

JEN TSUNG OR KWANG KING.

SHUNTI.

The Yuan dynasty from Kublai's reception of the southern kingdom in 1280 to the accession of Shunti in 1333, was generally satisfactory to China, and probably a model administration for the Orient.

Shortly before the accession of Shunti, earthquakes and floods

had devastated the northern provinces, and the provincial revenues of food and money had been exhausted. Vast sums were needed to repair the disasters, and policy required and necessity obliged local remissions of tribute from the impoverished. Before full succor could be brought, thousands of houseless, masterless peasants had taken to brigandage for a livelihood, and on the repetition of the disasters the number of husbandmen turned robbers yearly increased. They went south. To collect the tribute in the maritime provinces and in the interior, to bring it north and distribute it, needed all the forces of the empire administered by Tartar energy. There was war with Corea, and the imperial armies were disastrously defeated. The Kin Tartars had again got their breath and invaded China to play again for the lost kingdom. The Emperor began to meet this situation as a boy of thirteen. His ministers, his generals, his armies, his provincial system made head against revolt at home and invasion from abroad for thirty-five years. The general who finally dethroned him was a native Chinese, Chu Yuen Chang. He had been bred a priest, had enlisted under Kwoh Tsee Hing, a revolted chief, was promoted for merit, and married his patron's daughter. In 1355 Prince Kwoh died, and General Chu took the command of an army with the rest of his wife's inheritance. The unfrocked *bonze* took the side of order, and adopting Kublai's strategy, moved from province to province. He set up and made efficient the administration of each province, and gave the executive officers a sufficient rural police, thus localizing part of his army under competent command. He re-established the course of trade, restored interrupted communication by cara-

KWOH TSEE HING.

van and canal, and allowed the customary tribute to go forward to Peking. He claimed only to be duke of a province, a mere feudal chief, and to act only when the legal authority had been disturbed, and then only to restore it by appointing a new magistracy, which was always Chinese. Two upstarts prematurely announced themselves claimants of independent sovereignty. One of these, Chen Yeo Liang, took possession in 1363 of the narrow gorge at the corner of the three present provinces of Hupeh, Kiang-Si and Ngan Hwei, through which a third of the trade of China must pass,—the surplus and the imports of two-thirds of an hour of longitude and of about eight degrees of latitude—a defile controlling the water transportation west of longitude 116° and south of latitude 32°, and held it by a fleet on the Yang-tsee Kiang and Poyang Lake. The fleet was captured or destroyed in a series of naval engagements relentlessly prosecuted day after day till the ships were burned or sunk and the claimant drowned in the lake. The artist of the battle represents his wild-eyed head as the single object above the surface of a broad waste of waters to show the fulness of the victory. After this Chu refused to claim the Dragon Throne. The other claimant, Chang She Cheng, challenged in 1367 the authority of General Chu by proclaiming himself king of Wu, and was promptly crushed. In the rejoicing over this victory the soldiery demanded an end of subjection. For thirteen years they and they only kept the peace of the empire south of the Yang-tsee. No imperial army had aided or opposed them. What if Shunti were Emperor, he was a Tartar, and it was time that China should be for the Chinese. The yellow mantle was assumed and the dragon-flag displayed on New Year's day, 1368, and the revolted power of southern and western China marched on Peking. An advance up the canal converted much of the empire into the commissariat of the insurrection. A heavy flanking column moving through Honan captured the river and canal system from that province and from Shensi. Within four months the larder of Peking belonged to the insurgents. The Emperor held only the capital, its magazines, a few square miles around it, and the relics of his Tartar army. One last spring

END OF BATTLE OF POYANG LAKE.

at the throat of his adversary and at the fleet of supply-boats on the canal was defeated, and Shunti and his court retired to the north, leaving his capital to the victor. China had united against Yuan, and the Mongol had yielded. The Chinese say that the armies of Shunti were well supplied with artillery.

CHANG SHE CHENG.

With the brilliant men who had aided to establish the Ming dynasty, the Hung-Wu epoch had no difficulty in forming an efficient ministry and an able provincial administration. The Emperor trusted them more than had been customary for nearly a century, and devised a system which made the provinces almost independent principalities, owing to the Empire, after their magistrates were appointed, nothing but homage and tribute. The Emperor's family became powerful princes, with governments and independent revenues derived from the taxes of their government. He established his own court at Nan-King, and gave his fourth son, Fo, the northern subdivision, with the title of King of Yen. This prince, who inherited much of his father's genius for war, was sent into Tonquin with an army in 1401, and was defeated with great slaughter by the "fire-weapons" used by the enemy. In 1403 Prince Fo ascended the throne by the regnal title of Yung-lo. He employed cannon in his revolt against his nephew. His generals four years afterwards used fire-weapons to secure victory over the Tonquinese. The Ming historians who relate this say that these instruments were called Shen Khi (divine machinery) and that the Shen Khi Ying was organized by the Emperor to have charge of them. The Ming historian attributes to this war in Cochin China and to the Shen Khi brigade the introduction of firearms and war-rockets into China, and goes on to explain that they were kept a State secret for many years, and, although known to high authority and used in the armament of

forts, they were not allowed to be made away from the capital, or to be publicly seen until after the beginning of the sixteenth century, and were not generally introduced in the army before 1522.

Mr. Mayers, of the English legation, read before the North China Branch of the Royal Asiatic Society in 1869 a paper "On the Introduction and Use of Gunpowder and Firearms among the Chinese." This was published in the Society's Journal and also as a separate pamphlet. It may be consulted at the Boston Public Library, and also in the library of the Artillery School at Fort Monroe.

Mr. Mayers was unable to admit an earlier use of rockets or guns than that of 1403, in the reign Yung-lo. Dr. Edkins, of the London Mission, in a paper printed in U. S. Ordnance Notes No. 312, of July 6, 1883, reviews the ground and concludes in favor of a use of projectile artillery by the Sungs before 1280, but thinks the secret was lost under the Mongols.

Chu-Yuan-Chang
first Emperor of the
Ming Dynasty.
Dynastic Title
Hung Wu.

In transmitting a Chinese print of Shunti, Mr. Wong writes, using the Chinese characters for the name, "Shunti was the Emperor whose armies were amply provided with guns."

The evidence above cited is ample to state these propositions as facts:

1. There was an ordnance and artillery department in China called Pen Fu, as part of the Ministry of the Household, as early as 1284.

2. As early as 1284 firearms were well known to the higher army officers, and just before that year had been successfully employed against Chinese armies.

3. This ordnance department continued as an active organization into the reign of Shunti, who fled in 1368 into Tartary.

4. In reorganizing the administration of China, on the decentralizing plan of the Mings, this department was not continued, probably for the reason that most if not all of the personnel had fled across the frontier with the dethroned emperor.

5. When artillery is next needed in the reign of Yung-lo, a new artillery and ordnance office is created under a new name, which keeps the manufacture of cannon quite secret till about 1522, or about the time the Portuguese arrive in China.

This state of facts, or of facts and high probabilities, exclude all Kwei Chow years from and after A. D. 1273 inclusive, for we have the flight of the Mongol Emperor and his personal ministry in 1368 and 1369, and the reorganization of the government of China at Nan-king and the establishment of a less dependent provincial system in 1368–9.

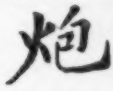
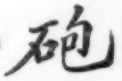
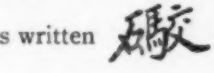
PRINCE FO AS KING OF YEN.

For some years there was no central ordnance or artillery department. When it reappeared it was by a different name. Curiously enough the revival is first mentioned in the revolting army of Prince Fo, King of Yen, just before he becomes Emperor. It was therefore first reorganized as part of his great northern establishment, and perhaps, indeed probably, was got together by collecting the workmen, the models and the traditions left behind by the Mongols. If so, a Shen Khi could probably have been found at Peking to organize a brigade of gunners, the sound of whose name expressed in other characters could well express the "divine machinery" then introduced.

The Ming provincial system, when administered by less energetic men than its founders, did not yield peace and order within or without the empire, and to its inefficiency may be attributed the disorganization which led to the substitution of the present dynasty.

Col. Favé, who completed the Emperor Napoleon III.'s elaborate treatise on Artillery, investigated this subject of early artillery with great care, and found saltpeter mentioned as early as 1240 in Arabic literature. It had then been long known in Egypt as Chinese snow. Before the end of another quarter of a century, directions had been given for purifying it and for combining it with alder or willow char-

coal and with sulphur, in proportions, fit for rockets, of six parts niter, one part sulphur and two parts charcoal. Crackers and serpents were also described. Before the end of the century the rocket was described by another Arab as the "arrow of Cathay." About the beginning of the next century (A. D. 1300) a breech-loading gun was described as an arrow-shooting "Mad-faa," and a drawing of it was given. The drawing was a mere diagram, about as good as Benton's in the U. S. Ordnance Manual, and was evidently made by a person who had seen the machine. The description as evidently was written by a man who was struggling with a subject imperfectly understood. It requires the breech-block to be tied in place by a raw-silk cord, and prescribes that the shaft of a spear shall be bored out for the barrel and recessed for the reception of the breech-block. The name Mad-faa is quite beyond any real etymology. Yet seemingly our study suggests an explanation.

The sound "Pao" signified in Chinese at a very early period a machine for throwing stones. The same sound has been continued for the stone-throwing cannon, as for the stone-throwing catapult. The character which represents this sound has suffered these modifications as the generic idea has changed. Now it is written  suggesting an envelope of fire . The form which preceded this was  suggesting a stone wrapped up. At a still earlier date it was written  suggesting a stone striking a horse. Mr. Mayers brought this out clearly in his paper.

The elements of these characters receive no phonetic notice from the Chinaman, but they suggest ideas to him as he reads.

This archaic ideograph made known by Mr. Mayers fully explains the situation which gave Col. Favé's Arabic author his name, his accurate picture, his confusing description.

Three people at least were concerned in it—a Chinaman who made the drawing and described it in Chinese and wrote out the Chinese name, an Arab who put the questions about the drawing and wrote out the answers in Arabic in a connected form, and an interpreter

who had probably an imperfect knowledge of both languages. The Chinaman would have no conception that any one would want to give a phonetic value to the ideographic elements of the written character. The Arab would, from the structure of his Semitic language and alphabet, lack the conception of a character in which the elements were not phonetic. The interpreter would fail to make two minds come together or appreciate their degree of separation. The Arab, asking to have the name written for him, would see the successive elements marked down, and would learn that they were 石 *shih*, which he would understand to be the projectile, and 馬 *ma*, horse, 大 *ta*, great, 交 *pa*, strike, all forming the one word *pao*. Naturally he would combine these syllables phonetically in the natural Arabic manner and produce the word Maatpa or Madfaa.*

MADFAA, AFTER FAVÉ.

The very syllable that is redundant in a Chinese etymology betrays the Chinese source of the Arab's information, and the diagram of the machine shows the breech-loading system we are considering. The item about the silk cord will be considered later.

We have found this type of piece existing early in the fourteenth century and described by a name fairly traceable to a Chinese origin by a Western writer of the period. We are now prepared to believe the statements of Dr. Edkins, that Western cannon were used in

* Evidently the fractional character above taken as *ta* was so called by the Chinaman, although it is written in the derivative form 六 *luh* (six); and the form rendered *poa* (strike) was pronounced as in its primitive or radical form 八 *pa* (eight); the two in combination having the sense of nearness, contact, or striking.

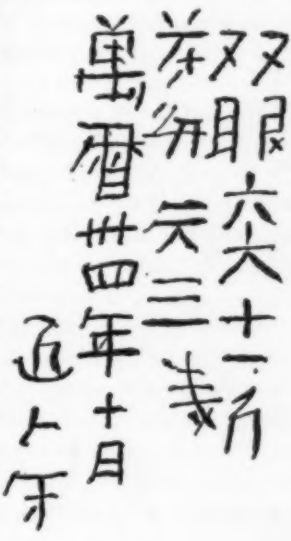
1234 at Tsai Chew, and that a "fire exciting hand gun," or, as Col. Favé calls it, a "furious firing spear," was known as early as 1259. This last was said to be made of a large thick bamboo, and to have had a projectile called by Favé a nest of seeds, and by Dr. Edkins thought to be an explosive bullet. The many fanciful names given to cannon in Europe which have finally settled into "cannon" (great reed) should prevent any surprise at the description of a gun-barrel as a bamboo. Marco Polo's statement that the Chinese used in war bamboos, the explosion of which could be heard for leagues, may lead us to imagine that some such word was employed in this sense in the thirteenth century.

To explain this statement about the "furious firing spear," Admiral Rodgers brought us another witness.

THE CHARLESTOWN GUN OF 1607.

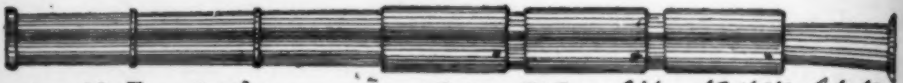
There is at the Charlestown yard a curious bronze gun from the same Corean capture.

It is about eighteen inches long. It weighs some fourteen pounds. It is double-barreled. It has three reënforces on each barrel. Each reënforce has a vent, those of the left-hand barrel on top, those of the right on the right side. The barrels are modeled to represent stocks of bamboo, and reënforces to represent root-knots. It has a hollow cascabel and no trunnions. The cascabel is very much worn and grooved as if by a lashing of small stuff which had attached it to a shaft (the raw silk cord of the "madfaa"). It bears an inscription on the cascabel, of course much abraded, but still legible in most of its important parts. It was made in 1607.



It reads: (Col. 1) Double-sighted six shooter, weight eleven catties. (Col. 2 is nearly illegible, most probably it once read) Tcha Fu Shi San Chuen (the Tea Prefect San Shuen or of San Chuen). (Col. 3 is quite legible) Wan Lik thirty-fourth year, tenth month day. (Col. 4) master workman Chu.

Wan Lik was the regnal title from



Double barrel Magazine Gun Reign Wan-Lik, AD 1607. At Navy Yard Charlestown - Mass. Corean capture of Gov. Rogers.

CHARLESTOWN REPEATER.

1573 to 1620 of an emperor in whose reign the Japanese invaded Corea. History records that in this war, in 1593, a general's horse was killed by a cannon shot, and in 1598 a cannon shot was used as a signal. Griffis' "Mikado's Empire" states that a breech-loading cannon is still preserved in Japan as a relic of this invasion.

This curious early repeater fully illustrates the furious firing spear with its nest of seeds and its bamboo barrel of the Sung period, and we are no longer obliged to reject the evidence of the writers of the Sung, Kin and Yuan histories because we do not understand it.

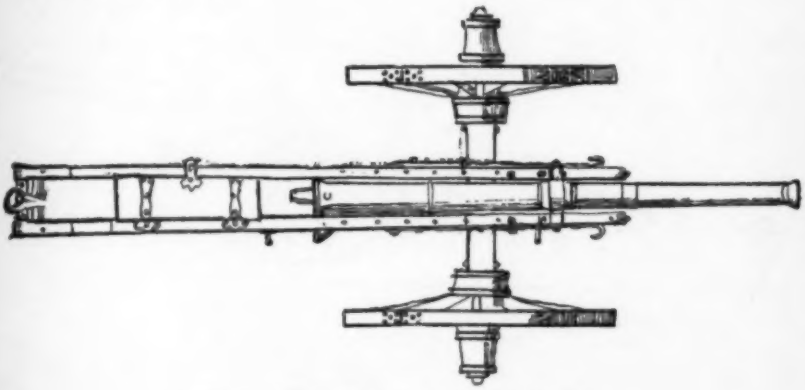
We have also discovered another thing, that some scion of the Shen Khi family of 1313 must have remained in China, because we find one of that name in 1665 at work manufacturing guns, and it is possible that the Shen Khi brigade may have been originally named for one of them before it got its literary form. This, however, is mere conjecture.

All these breech-loading guns were called by the founders by the special name Fulangkhi. Mr. Mayers cites a Chinese author who wrote about 1517 concerning the Portuguese. He spoke of their guns by this name, and said that this name was rightly a name of a country and not of cannon. Mr. Mayers conjectured that the Portuguese had been called Franks by some person, and the name had been transferred to the guns. No evidence is found anywhere that the Portuguese were ever called Fulangkhi's, and Mr. Mayers apparently did not know that the term continued to be an official term for guns as late as 1680. The Portuguese guns are said to have been of iron, jacketed with wood and strongly hooped. This hardly was the model from which to make a brass gun like these of this museum.

Again, these Chinese Fulangkhi differ from the pedreros of Europe by having hollow instead of solid cascabels, which seems to imply a different course of development. Undoubtedly Fulangkhi might mean French. As undoubtedly, in some of the treaty ports to-day, Fulang is taken for France, and for foreign generally. Probably when the set of characters were devised to designate the machine it

was believed to have come from abroad with some barbarian invader from the West. When an Arab calls the rocket the Arrow of Cathay, and the breech-loading cannon Mad-faa, he goes far to admit an early use of gunpowder in China wars; and when the Chinaman speaks of Western and of Mahommedan cannon and of Fulangkhi, he goes far towards calling the instrument an imported article. We are not called upon to settle the place of origin of this class of weapon exactly, but only to date one gun.

Our date for that has been fixed at A. D. 1313, and the only catalogued gun older than this is the Fulangkhi of Fort Monroe, made in the same month.



BURGUNDIAN GUN, PLAN AFTER FAVÉ.

It is pretty clear from some old bills and accounts that gunpowder artillery was used in European war before 1300. It is not disputed that the hand-grenade was used in China as early as 1233. We have no drawings of any gun except the "madfaa" earlier than the fifteenth century.

Some ancient guns are preserved in Europe and Asia, and the Royal Artillery Institute have published a series of papers by Lieut. Brackenbury which describe and illustrate some of the most curious of them. They date as follows:

1318. Bombard at Amberg, Bavaria.
1379. Wooden-cased gun at Venice.
14th century. Tower guns, London.
1423. The Michelettes at St. Michel.
1430. La Dritte Geriete of Ghent.

1460. Mons Meg at Edinburgh.

1464. Turkish guns at Constantinople.

1475. Captured in 1476 and 1477. Guns of Charles of Burgundy at Morat and Neustadt.

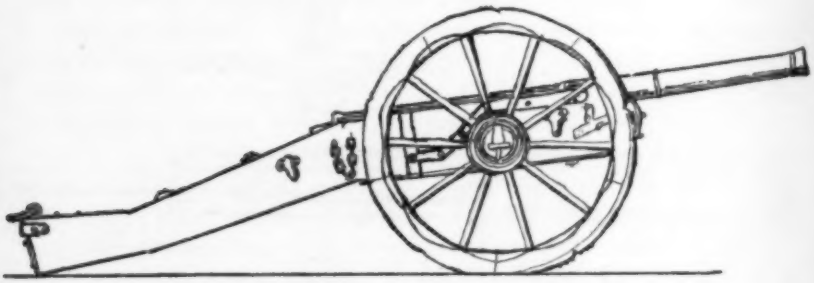
1478. A gun of Louis XI. in the Paris Museum of Artillery (structure not described.)

1535–1539. Two sakers at Woolwich.

1542. The Mary Rose guns at Woolwich. All by Arcano de Arcani.

1546. Czar Pooschka at Moscow.

16th century. Malik y Mydan at Benares.



BURGUNDIAN GUN AT NEUSTADT, AFTER FAVÉ.

Besides these is the double-barreled draconcillo cast at Liege in 1503, now at Madrid, and the Bartemy de Pins gun of 1490 at Paris, and the banded gun in the Tower, about 1545.

Probably the above list contains more than half of all the guns now extant made before 1500. There may be fifty guns now extant made in the sixteenth century.

De Saulcy declared that the most important improvement in field artillery was the introduction of trunnions and the flask or bracket trail system of mounting, and that the origin of the improvement is unknown.

One gun of Charles of Burgundy, a cast-iron piece, may fairly be said to have this improvement. The Bartemy gun was doubtless so mounted.

Both these guns, however, were preceded in Europe by the swivel system, illustrated by the Cortes guns at Annapolis and Washington, which are undoubtedly older than 1474, when Isabella acceded to the throne of Castile. By her marriage contract it was provided,

in 1469, that after her access the arms of Aragon should always be associated with those of Castile and Leon, and, as these guns were marked with Castile and Leon only, this fact dates them earlier than 1474.

The pedigree of the Bartemy gun and of most European artillery is traced to the wooden-stocked guns of Burgundy by the adjustment of their trunnions lower than the axis of the piece, while the independent origin of the Cortes swivel, of the Madrid draconcillo and of the Fulangkhi's appears by the emplacement of their trunnions abreast of their bores.

Without attempting to account for the origin of the name Fulangkhi, it is worth remembering that the earliest illustration we have of the landing of St. Louis at Damietta represents his army as provided with cannon.

DE MOLAY.

TAMARLANE.

THE HISTORICAL PERSPECTIVE OF THE FULANGKHI OF 1313.

The war of Cortes in Mexico is a remote American event. It began twenty-six years after the first voyage of Columbus, nearly three and three-quarters centuries ago. The oldest Fulangkhi was then as old as the Cortes swivel was in the reign of Queen Anne. The year of Hwang King, called Kwei Chow, was at a notable period in the history of the world.

The Crusades were over. The modern period had begun. Robert Bruce was King of Scotland, and in another year he would win the independency of his kingdom at Bannockburn and strike down before both armies Sir Henry Bohun, the English champion, break-

ing his axe in the blow. Edward II. was then King of England, and English people were still discussing the recent fall and execution of Gaveston. Henry VII. of Luxemburg was Emperor, Dante was in his prime, and Petrarch was a schoolboy. Clement V. was Pope, and the Papacy was settled at Avignon under the protection of Philip the Fair. The order of the Temple had just been dissolved. De Molay was to mount the scaffold in a year, and to summon Philip in judgment at a year and a day of essoin, and Philip would be laid in his coffin in two years' time. The Polish mortgage to

SEAL OF ROBERT BRUCE—OBVERSE.

Brandenburg, never redeemed, had just laid the foundation of Prussian power. Russia then paid tribute to the posterity of Zenghis. The Arabic caliphates of Cordova and Grenada survived in Spain, and the last sigh of the Moor would not breathe farewell to the Alhambra for a century and a half, leaving its name to the overhanging hill. The grandsons of Rudolph held petty principalities in Germany, but the Hapsburgs were not a reigning family. Charles of Anjou ruled Hungary. Venice was sovereign over most of the Greek Empire, and Athens was an independent principality of a French duke. Tamarlane would be born in a quarter of a century,

but a hundred and forty years would elapse before the cannon of Mahommed II. should batter the walls of Constantinople.

Pope Sylvester had invented a mechanical clock, but a child born in this year 1313 would be over sixty years old before any French church would have one on its tower. It was two centuries before Europe knew of printing by movable types. Paper had been invented, was made in Spain, but France and Germany would not make it for a year, nor England for a century. Coal was only in use in the districts where it could be quarried. The use of water-

SEAL OF ROBERT BRUCE — REVERSE.

power was confined to the blowing engine called the *trompe*, and to driving the wipers of small trip-hammers. Road-making was a lost art. Wheel-carriages were unknown or of the rudest sort, and transportation in Europe per ton per mile was paid at the rate of thirty cents of our money. The impossibility of an internal commerce made local dearths and famines severe and frequent. No postal service existed, no common carriers of freight or passengers. Floors were strewn with rushes and walls hung with carpets. Sugar was a confection, and two centuries would elapse before it would be a food. No forks were used at table. Every guest brought his own

knife. Many European nations would not arrive at the accomplishment of making soap for centuries.

Of the things quite unknown in those days, but quite usual to-day, were alpaca, coca, coffee, cacao, and chocolate, cochineal, jalap, logwood, maize, manila or sisal hemp, Peruvian bark and the cinchona and quinine alkaloids, potatoes and yams, tea, tobacco and tapioca. Among those quite rare were cotton cloth and indigo. Canned meats and vegetables were quite unknown, and more than three-fourths of all the food was heavily salted or smoked, often both. It was before the days of the whale fishery. Street lamps were unknown, and houses imperfectly lighted. There was no window-glass, almost no drainage, and chimneys were very poor.

To reduce the commonest and plainest people of to-day to the supplies of the luxurious of 1313 would be to deprive them of many of the necessaries of life.

What shall we say of the metallurgic skill, of the mechanical advances which had been made, as shown by the gun itself? Drills, files, gravers, modeling in sand, coring, dry distillation, winning of sulphur from the volcano and of niter from the earth, a selection among charcoals for special properties, all must have been contrived, learned and practised before this gun was made.

Why, with this great advance thus early, has the Chinese development of firearms been so slow and apparently retrograde?

First. The national policy did not permit the use of firearms to the people, or to any but a limited part of the army.

Second. The soldier till quite recently was required to purchase the materials of his powder and to make it himself. We learn from Barrow that as late as 1793 a formula was in use which was deficient in saltpeter and called for an excess of sulphur and of charcoal. Moreover, the purification of the niter was defective. Granulation has not been thought important.

Third. Mechanical improvements have been neglected, and no attempt made to get a more modern type of gun than the match-lock. Small-arms of inconvenient weight have been preferred, and the cartridge was never thought desirable.

Fourth. Candidates for commissions or promotion have been deterred from attempting improvement by the rigid formalism which required adherence to the ways of the past at the age of acquisition, as a condition of success in the schools.

Fifth. A preference of provincial authorities for local economy

rather than for national efficiency and power. This again is but another name for the unsympathetic selfishness which Kublai meant to correct.

Sixth. The peaceful relations of China with the rest of the world other than Asiatic nations unskilled in mechanics have made the situation of comparatively small consequence till recently.

The tributary relation of Corea to China accounts for the presence of these weapons in that kingdom.

It is, however, strange that an American naval force should have captured in one day five guns, all of them older than the time when white men first occupied the great Mississippi River system, the cotton and corn field of the world.

Two of these guns were far older than the time when America was first brought to the knowledge of Europe; a third, the Charlestown repeater, was made in the very year in which Virginia was planted; a fourth, in the year when arbitrary government was threatened to Massachusetts by the appointment of the Carr-Maverick commissioners; and the fifth, in the year the first royal government was established by the charter of New Hampshire, and the only feudal government ever set up in the old United States territory was established in the Massachusetts province of Maine. It is strange that this force from the New World should have brought them from that Far Cathay, whose fame was the cause of the expedition of Columbus, and it is stranger still that men should be living to-day, still in active service, who can say they have heard the hostile roar and have been exposed to the peril of shot projected from the oldest extant pieces of artillery of the world.

PROFESSIONAL NOTES.

THE SCREW FERRY-BOAT.

By E. W. WOOLSEY, Superintendent Hoboken Ferry Company.

As early as 1805, a screw steamboat, constructed by John Stevens, made a run as a ferry-boat between Hoboken and the city of New York. This boat was about 24 feet in length, built upon the Whitehall pattern, and was propelled by twin-screws at the stern. The engines of the boat are now in the Stevens Institute of Technology at Hoboken.

The steam ferry-boat from its introduction in 1812 has always been of the sidewheel type, although as early as about 1850 the construction of a screw-boat for ferry service was contemplated, and indeed plans for such a vessel prepared. In 1867 the subject was again agitated, but the project abandoned under the belief entertained that such a mode of propulsion was impracticable, chiefly because of the fear that no screw could be made to stand against the ice that packed in the ferry-slips.

The gradual increase in traffic between the cities in the port produced a problem as to how best to meet the subject and provide adequate facilities. No more landing-places in the city of New York could be obtained than were already held by the various companies, and without additional landings a greater number of boats could not be run with any advantage to the public; larger carrying capacity must therefore be provided.

In 1887, with this problem before them, the Hoboken Ferry Company commenced the design for a screw ferry-boat. Without any previous experience upon which to build, nor yet any vessel of approximate character to consult, the Bergen was designed, built, and in March, 1889, was placed on duty where she has since performed a most satisfactory service both as to speed, economy, facility of handling and increased capacity, which is 29.8 per cent more than a sidewheel ferry-boat of equal length and breadth. The following table will compare the Bergen with one of the sidewheel boats of the Hoboken ferries:

TABLE.

HULL.	Bergen, Steel.	Moonachie, Wood.
Length L. W. L., feet	200.	200.
Beam " "	32.16	32.
Beam over guards	62	62.
Draught to base line	8.83	7.5.
Space available for passengers	4330 aft	3335 aft.
" " " teams	3448 aft	3380 "
Number of seats for passengers	296	236.
Engine—type	T. Ex. Propeller	Low press. beam.
Size	18½" x 27" and 42" x 24"	44" x 10'
Steam pressure	160 lbs	30 lbs.
Average HP in regular service	665	450 estimated.
Speed measured mile	14.6	
Average speed in regular service	13	11 estimated.

By comparison with the largest sidewheel boat in the service, the Bergen will consume 9 per cent less coal to produce the same results. The perform-

ance of the screw ferry-boat in ice is such as to place it far in advance of any other type of boat required to make a head-on landing. The screws (submerged two feet below the surface of the water) have never suffered breakage by contact with ice, nor has the speed been materially affected in passing through large fields.

The hardest ice service, however, is that which is packed in the slip and held fast by the bridge pontoon in front and the racks on either side. While under these conditions there are times when the sidewheel boat cannot force her way to the bridge, but the screw-boat makes her way without difficulty, the forward screw clearing the pathway for the entrance of the hull, and at no time, even under the worst conditions, has the use of a gang-plank been necessary for the landing of passengers or teams.

The peculiar model, in which are employed a full, flaring upper body, a very fine under-water body, with a full water-line and a sharp V-shaped midship section, and the peculiar cutting away of the ends to bring the rudder and screws within the perpendicular of the stems, is responsible for the stability of the vessel, the ease of entrance and clearance, and of her valuable ice qualities.

The fact of the screws being upon one shaft, and the forward one pulling when under headway and meeting a most solid resistance when reversed, renders the stopping qualities exceptionally good, and experience has demonstrated that the screw-boat can kill her headway and come to a dead stop in about half the resistance required by a sidewheel boat. The steering qualities are all that can be desired, the helm being answered very quickly and with great steadiness.

Following the Bergen, and after she had proved her value by actual service, the N. Y. L. E. and W. R. R. Co. constructed the John G. McCullough, following the same general principles though differing in detail. After this the P. R. R. Co. produced the Cincinnati, and about the same time the Bremen and Hamburg were commenced by the Hoboken Ferry Company. All of these are now in successful operation.

The writer has the honor of having been intimately associated with the designing and construction of the Bergen, Bremen, and Hamburg, as well as now having charge of their operation, and while making no attempt at a scientific consideration of the subject, has endeavored to submit something of the history of the screw ferry-boat and the results thus far obtained.

It has not been found that the screw-boat is more economical than the beam-engine boat as to fuel, manning or repairs, but its commercial value in carrying capacity, facility of loading and unloading, and ease of motion, added to the perfection of handling to which I have alluded, renders the type one which must inevitably be adopted by all ferry corporations who have to face the constantly increasing tide of travel to and from the great metropolis.

THE FIRST-CLASS CRUISER EDGAR.

(From *London Engineering*.)

We have completed our description of the cruiser Edgar and of her machinery, and have given the general results of speed trials; but these are worthy of more careful consideration, both on account of their interest and also of their rarity. For it must be noticed that, while private firms can systematically carry out elaborate speed trials of all their ships, or test the performance as to consumption of steam, etc., of all their engines, and find this to pay; while also thousands of pounds and months of time can be given to try torpedoes, nets, etc.; while we can afford to send torpedo-boats full tilt at floating fortresses; yet we are, we believe, correct in saying that not one thorough speed trial has ever yet been carried out in the navy, and we are perfectly sure that the consumption of steam of not one engine of a ship of war is known. It may be, of course, that the trials of the Greyhound in 1873 finally settled all questions

regarding the resistance of ships, and that we now need nothing but model experiments, though we should be sorry to state that this is so; but they certainly settled nothing about the engines. However, no doubt the efforts of private firms will in time supply us with facts sufficient to complete, so far as such a thing is possible, our knowledge of the steam engine; and meantime the highly educated young engineer officers, on whose training the Admiralty spend a fair amount of money, can go on as usual settling the exact dimensions of a stoker's blue collar, or seeing that he spills no drops of oil to mar the purity of the first lieutenant's clean decks.

We give in tabular form the results of seven trials on the measured mile at Stokes Bay, and for comparison the two contractors' trials for acceptance of the machinery at Plymouth. In order to show the results clearly, they are plotted graphically on a diagram accompanying this article, the horizontal scale being of knots, and the vertical the corresponding indicated horse-power, the curve *ABCEFG* is then drawn through the spots obtained. Before, however, the curve can be drawn, a correction must be made, because, as will be seen from Table I., the trial is marred by a change of draught. The trials were to be at or about 10, 12, 14, 16, 18 knots and full speed, and the 10, 12, and 14 knots trials being made on one day, the draught was for some reason or other altered before continuing; then a trial at about 13 knots was made, in order, we presume, to bring the two sets of results into comparison before proceeding with the 16 knots, etc. This change of draught is unfortunate, but we can only endeavor to allow for it by estimating its probable effect. We calculate thus:

	ft.	in.
Mean draught on 24th	23	2½
" " " 27th	23	9
Change of draught, or 2.27 per cent.	0	6½

This change will mean an increase of about 4½ per cent on the wetted surface, and hence also on the indicated horse-power.

We add then 4½ per cent to the 10, 12, and 14 knots indicated horse-powers; and we also apply a similar correction to the two trials at Plymouth, adding 4 per cent to the full-power trial indicated horse-power, and subtracting 1 per cent from the natural draught trial indicated horse-power. Doing this we obtain the numbers in the second column of Table II., and plotting these in the diagram, obtain in order the points *KGLFEDCBA*; we should then draw a fair curve through these points, except *K* and *L*, but it will be found that we cannot bring the point *D* into a fair curve, so we are obliged to leave this point out and conclude that probably some inaccuracy occurred in that particular result. There will also be noticed a slight flatness at *B*, appearing to indicate that the indicated horse-power given for this speed is somewhat large; but still, the want of fairness is small; and remembering that *C* is for the same day and conditions as *E*, *F*, and *G*, we should not attempt to draw a curve including *D*, but decide that the results for *D* are in some way inaccurate as just stated.

In order to separate, if possible, the engine efficiency or a part of it, we next draw the curve of indicated thrust. In column 4, Table II., we have the speeds of the screw calculated; and, dividing the energy exerted per minute by the engine by these, we obtain column 5 of indicated thrusts. These values are plotted in the diagram at *kglfedcb* and *a*, and the curve of indicated thrust for the progressive trials should pass through *gfedcba*. But we now find that not only is *d* out of the fair as we should expect, but also the slight want of fairness at *B* is on this curve accentuated, so that *b* lies above the straight line joining *a* and *c*. This shows us that the results for *B* and *A* are not consistent with those at *CEF* and *G*; either *B* and *b* are too high or *A* and *a* are too low, or both. Thus altogether it appears that we cannot attach much value to the lower results, and it is therefore of no use to attempt to determine the constant engine friction, by prolonging the thrust curve to cut the vertical axis, even supposing the lowest speed determined, viz., 9.647 knots, had not been too great to use for this purpose.

TABLE I.—*Details of Trials of H. M. S. Edgar.*

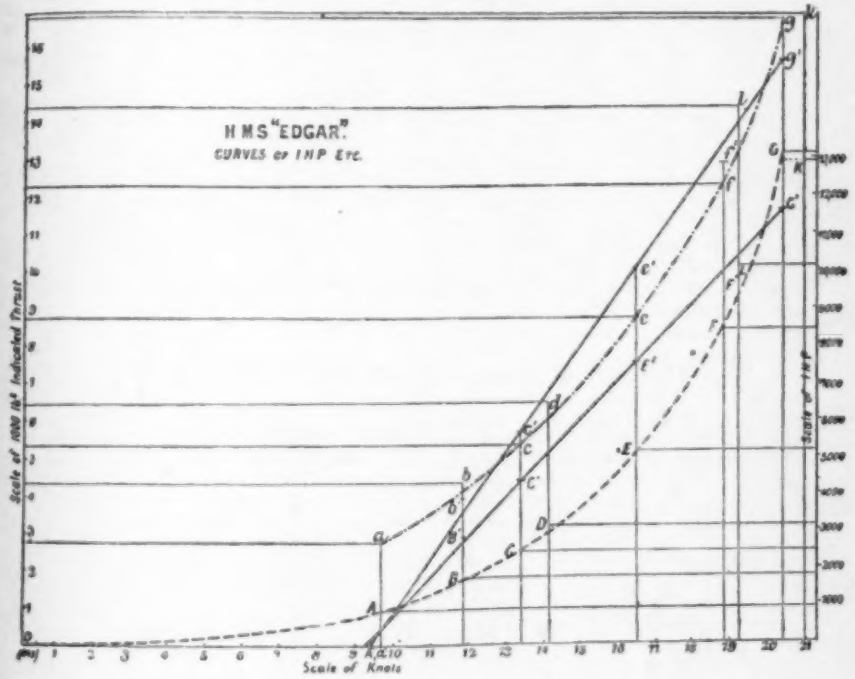
	Trials off Plymouth,		Progressive Trials on Measured Mile at Stokes Bay,						
	Natural Draught.	Full Power.	10 Knots.	12 Knots.	13 Knots.	14 Knots.	16 Knots.	18 Knots.	Full Speed.
	Nov. 4, 1891.	Nov. 19, 1891.	Nov. 19, 1891.	Nov. 24, 1891.	Nov. 27, 1891.	Nov. 24, 1891.	Nov. 27, 1891.	Nov. 27, 1891.	Nov. 27, 1891.
Draught of water { Forward	23 ft. 3 in.	22 ft. 9 in.	22 ft. 8 in.	22 ft. 8 in.	23 ft. 0 in.	22 ft. 8 in.	23 ft. 0 in.	23 ft. 0 in.	23 ft. 0 in.
Draught of water { Aft	24 ft. 6 in.	23 ft. 10 in.	23 ft. 9 in.	23 ft. 9 in.	24 ft. 6 in.	23 ft. 9 in.	24 ft. 6 in.	24 ft. 6 in.	24 ft. 6 in.
Revolutions	99.2	104.5	45.3	55.9	63.1	65.9	79.3	92.8	106.2
Pitch of screws	23 ft. 4 in.	24 ft. 4 in.	24 ft. 4 in.	24 ft. 4 in.	24 ft. 4 in.	24 ft. 4 in.	24 ft. 4 in.	24 ft. 4 in.	24 ft. 4 in.
Speed	19.25	20.97	9.647	11.87	13.4	14.015	16.512	18.836	20.488
Indicated horse-power	10,179	12,463	880	1690	2464	2997	5102	8401	13,101

TABLE II.—*Analysis of Results of Trials at Progressive Speed of H. M. S. Edgar.*

Speed. Knots.	Indicated Horse-Power.	Revolutions.	Speed of Screw.	Indicated Thrust.	Speed of Ship.	Slip per cent.	Log Speed.	Difference.	Log Indicated Horse-Power.	Difference.	Power of Speed which Indicated Horse-Power varies as.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
			ft. per min.	lb.	ft. per min.						
20.97	12,961	104.5	2542.8	16,821	2124.96	16.4					
							1.3114996		4.1173044		
20.488	13,101	106.2	2584.2	16,730	2076.117	19.7		.0365109		.1929734	5.3
19.25	10,077	99.2	2314.7*	14,366	1950.67	15.7			3.9243310		
							1.2749887	.0571890		.2165905	3.78
18.836	8,401	92.8	2258.1	12,277	1908.715	15.5			3.7077405		
							1.2177997	.0906949		.3160998	3.48
16.512	5,102	79.3	1929.6	8725.4	1673.216	13.3			3.3916407		
							1.1271048	.0526541		.1446500	2.74
14.015	3,132	65.9	1603.6	6445.2	1420.187	11.4			3.2469907		
							1.0744507	.0900584		.2832029	3.14
13.4	2,464	63.1	1535.4	5896.8	1357.87	11.5			2.9637878		
11.87	1,766	55.9	1360.2	4284.5	1202.83	11.5	1.0744507				
9.647	920	45.3	1102.3	2754.2	977.563	11.3	.9843923				

* Pitch 23 feet 4 inches for this trial.

One point, however, is very clearly shown by the true, *i. e.* upper part of the curve, viz., the loss of speed due to the drag of the bottom in the comparatively shallow water of the measured mile. It will be noticed that the points $K'k$ lie below the fair curves, while Ll for the natural draught trials lie above. The latter, however, need not be considered, since there was in that case no special need for great accuracy in the determination of the speed. But on the full-power trial the speed was determined with considerable accuracy; and it will be found that, drawing through K a parallel to the base, this cuts the indicated horse-power curve just half a knot to the left of K. We conclude then that at Stokes Bay, with the same indicated horse-power and draught as at Plymouth, the speed obtained would have been half a knot less; this half-knot then must be the loss due to the bottom drag.



The third set of points on the diagram $A'B'C'E'F'$ is plotted by drawing ordinates representing log indicated horse-power, the base line being taken such a distance below OA that the spot corresponding to the lowest speed may fall on A', or, which is the same thing, the ordinates from the base line in the figure represent the difference of the log of each indicated horse-power from the log of the smallest one, viz. 920. If the relation between indicated horse-power and speed were

$$\text{Log I.H.P.} = a + bV,$$

where a and b are constants, then the spots would all lie on a straight line. In the figure a straight line is drawn through C' and G' which passes very near to E' and B'; but F' lies considerably below it, a result we should hardly have expected, since neither in the curve of indicated horse-power nor of thrust is

there any sign that the results of this trial are low. Of course we should not expect B' or A' to come in fairly, but we see that B' does very nearly; so that the probability is that the unfairness at B and b is due to a too small value of the indicated horse-power at A.

A law which is sometimes assumed to represent the facts very closely is

$$\text{Log}\,\frac{\text{I.H.P.}}{\text{revolutions}} = a + bV;$$

or, as we term it,

$$\text{Log (indicated thrust)} = a + bV.$$

To test the correctness of this law the points $a'b'c'e'f'g'$ are plotted in a similar way to $A'B'$, etc., a' and A' coinciding to start with. But there being room on the diagram the scale is double that of $A'B'$, etc., which accounts for the greater slope of abc. So far as can be seen this law is no closer than the preceding, the only difference perceptible being that the line $a'c'$ lies closer to or more evenly between a' and b', thus tending to divide the inaccuracy between the two trials; f' again is below, and e' practically on the line.

The remaining columns in Table II. show: The slip per cent, where it will be seen the 14-knot trial again is anomalous; and also the very great increase of slip at the maximum power shows that the ship is reaching the limit of speed for her size and form; and the calculation of the power of the speed according to which the indicated horse-power varies between the different speeds; the results in column 12 are obtained by dividing those of column 11 by the corresponding figures in column 9. The 14-knot trial is omitted, and the numbers found point to the unfairness at B, and also, seeing the sudden increase from 3.78 to 5.3, to a possible understatement of the indicated horse-power at 18.836 knots.

THE FISKE ELECTRIC POSITION-FINDER.

(From *Iron Age.*)

Some time since Lieut. Bradley A. Fiske, U. S. N., designed a range-finder consisting of two telescopes placed at the ends of a measured base and connected in such a way with a galvanometer, placed in any convenient location, that the range in yards of the object on which the telescopes were directed was read directly from the deflection of the needle. The two telescopes were connected by a telephone, so that there was no difficulty in directing both telescopes at the same object. By adding another galvanometer to the instrument, says *Engineering*, from which we quote, Lieutenant Fiske finds he can so arrange matters that the reading of the instrument gives at sight the angle which a line joining the object aimed at and the center of the telescope base-line makes with the base line, so that by this addition his range-finder is converted into a direct-reading position-finder, giving at once both the range of the object in yards and its direction. If, therefore, the guns are placed near the center of the base line, they can be directed on any desired object without it being necessary that that object should be visible from the battery. In the former finder the two telescopes were mounted on trunnions over a circular plate, around part of the periphery of which was placed a platinum wire, forming two arms of a Wheatstone bridge. The telescope carried a sliding contact which determined the proportion of platinum wire going to each arm of the bridge.

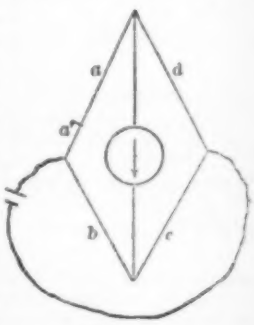


FIG. 1.

If the telescopes were aligned, say on a star, so that their lines of sight were practically parallel, each was displaced through an equal arc from its central position, and the sliding contacts divided each wire similarly, so that no current flowed through a galvanometer connected with the bridge in the usual way. If, however, the two telescopes were aligned on an object, say 3000 yards away, these axes were no longer parallel, the sliding contacts were displaced unequal amounts, and a current flowed through the galvanometer. This is shown diagrammatically in Fig. 1, where a and b represent one platinum wire, and c and d that at the other telescope. As long as $ac = bd$ no current will pass through the galvanometer; but if one contact is moved to the point a' the galvanometer is immediately deflected. Perhaps this is shown still more clearly in Fig. 2, where AB represents the base line at the ends of which the two telescopes are placed, represented by C and N. The arcs shown below the telescopes correspond to the arms ab, dc of the Wheatstone bridge in Fig. 1. If the telescope C occupies the position AD it will be parallel to BN, and the two arcs will be divided up similarly, so that no current will pass through the galvanometer. If, however, both telescopes are sighted on T, CA will no longer be parallel to BN, and the two arcs are no longer similarly divided by the sliding contact. Hence a current will pass through the galvanometer, the deflection of which will depend primarily on the difference between the angles through which the two telescopes are deflected from their new position on the angle ATB. By rearranging the connections, however, as shown in Fig. 3, the deflection of the galvanometer will now depend on the sum of the angles through which the telescopes are moved from the zero position. This rearrangement is practically the same thing as if the arc CD was given a half-turn round the axis XY. Then, in order that no current shall pass through the galvanometer, the telescope C must be in the position D, making an equal angle with the base to that made by telescope N. In such a case it is obvious that the line joining the object with H would make an angle of 90° with the base AB. But as the two telescopes have been moved in opposite directions from their normal positions, which is 90° with the base, the bearing of the object as seen through one telescope will be $90 + \theta$, and through the other $90 - \theta$, θ standing for the angle through which the telescopes are moved. The mean of these is, of course, 90°, or equal to the bearing of the object from H, the center of the base. Under the above conditions no current will pass through the galvanometer, which is accordingly graduated so that the point of no deflection is lettered 90°.

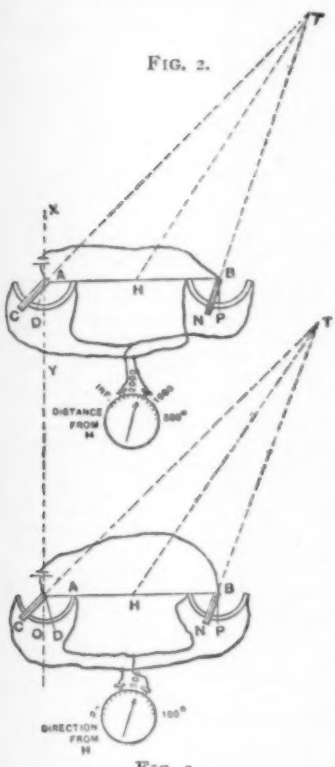


FIG. 2.

FIG. 3.

If, instead of the telescope C being at D', as supposed, both instruments are sighted in T, as shown, the arms of the Wheatstone bridge will no longer balance and a current will flow through the galvanometer, deflecting its needle.

This deflection will, as before, depend upon the sum of the angles through which the telescopes have been moved, of course taking regard to sign, and hence as before will denote the mean bearing of the object from the ends of the base, or, what is practically the same thing, the bearing as seen from *H*, the center of this base.

By using two galvanometers and coupling one up as just described, and the other as for the range-finder, it is obvious that both direction and range of any object can be obtained at the same time. This arrangement is shown in Fig. 4. The two galvanometers are connected to the telescope as explained, and the guns are situated midway between the telescopes, so as to occupy the center of the base line.

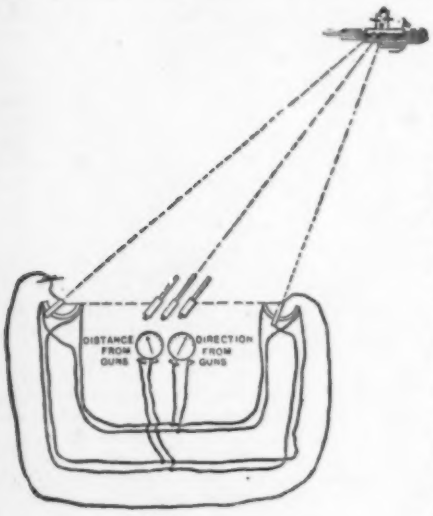


FIG. 4.

In practice it is found advisable to make the resistance of the direction galvanometer and its connections quite high, so as to interfere as little as possible with the indications of the range galvanometer, and in this way both direction and distance are obtained simultaneously and continuously. It will be seen that the telescope stations can be placed at any convenient points, and by suitable precautions could be rendered perfectly indistinguishable to an enemy at a little distance away. The guns, too, could be quite out of sight of the enemy, particularly if adapted to high-angle fire, so that by the adoption of this system the great desideratum of modern defensive tactics—viz., to give the enemy no salient point on which to fire—is fulfilled. In certain cases it may not be convenient to have the guns arranged midway between the telescope stations, as shown in Fig. 4, but the range and direction can easily be reduced to any other point once their values for a given point are known. It will be noticed that this new position-finder entirely avoids some of the inconveniences met with in using depression range-indicators and position-finders. The indications of the instrument are unaffected by changes, sometimes quite sudden, in the refraction of the atmosphere or by the rise and fall of tides. Furthermore, it is not necessary to sight at any particular part of the vessel, such as the water-line, which may be shrouded in smoke, but any one part of the ship, such as the top of a mast or funnel, or, indeed, any point that can be seen simultaneously from both telescope stations, is all that is necessary for the successful use of the finder. This new position-finder appears to us particularly suitable for coast defense, and we hope our War Office authorities may take the matter up and thoroughly test the value of the instrument for this purpose.

ENGINE AND HELM CONTROL.

The present means of communicating directions from the captain or the officers stationed on a steamer's bridge to the engineer or machinist on watch in the engine room, or to the quartermaster at the wheel, are either mechanical or

electrical. The mechanical devices are, as a general thing, cumbrous in construction, difficult to operate and quite easily put out of order. The electrical devices are almost always complicated and in addition are very expensive. There is, and has been for years past, urgent need for a simple apparatus by means of which the person directing the movements of a vessel may not only communicate his orders instantly, but may know with certainty that they are understood and are being executed. This is of the greatest importance aboard war-ships, where the outcome of a conflict in favor of one side or the other may be dependent upon the rapidity and facility with which the opposing vessels are handled.

It is a serious objection to the existing modes of intercommunication that they do not enable an order to be transmitted with sufficient accuracy. Thus it is quite possible to send a signal to put the helm, for example, to "port" or to "hard a-port" and to instruct the engineer to "back" or "go ahead" fast or slow, or to stop. But there is no reason why much more specific instructions should not be sent, by means of which the vessel may be more accurately controlled. This point receives particular emphasis when several vessels are cruising together or indulging in tactical manœuvres. In this case almost continuous engine speed-changes are required to enable the vessels to maintain proper distance. Furthermore, in action, with casualties constantly occurring, it is exceedingly important for the commanding officer to know that his orders have been clearly understood and implicitly obeyed. The more automatically this intelligence can be conveyed the greater the immunity from error and the more rapidity possible.

After a great deal of practical experience afloat and much study of the subject, Lieut. Bradley A. Fiske, United States Navy, has recently developed a signaling system of great ingenuity, which brings the guns of the battery, the helm and the engine room much more completely under the control of a single person than has ever hitherto been accomplished. The system includes numerous arrangements of apparatus, which are quite well represented in the accompanying diagrams. The system as here given is for use for controlling the engine or the helm. In a somewhat modified form it could be readily adapted for transmitting from the observer to the gun-captain the distance the target is from the firing position, as determined by the clever range-finders that have been adopted by our navy department and that of several of the foreign powers.

Referring first to Fig. 1. Here are shown two arcs of conducting material, over which move two pivoted arms, *B* and *H*. The arcs are graduated on each side of their central points to indicate the revolutions made by the propeller of the vessel. The arcs and arms are connected in series with two indicating instruments; one arc and one indicating instrument being located, for example, on the vessel's bridge or in the conning tower, the other one in the engine room. In connection with the needle of the instrument of the engine-room indicator are arranged two local circuits, each containing a bell or other suitable alarm, which circuits are respectively closed as the needle moves to its stops in one direction or the other.

If the apparatus be arranged as indicated in the diagram, the arms being at the middle points of their arcs, and it be desired to send a signal to the engineer to "go ahead," the arm *B* should be moved to the right. By this means the resistance in the circuit is diminished, causing a deflection of the needles of the two indicators in the same direction. The engineer then not only sees the needle of his indicator move, but also hears a bell sound. And as this bell may be of different tone, for example, from the one included in the other local circuit, he has both visible and audible notice of the order. Meanwhile, the person sending the order notes by the deflection of his indicating instrument that it has been transmitted.

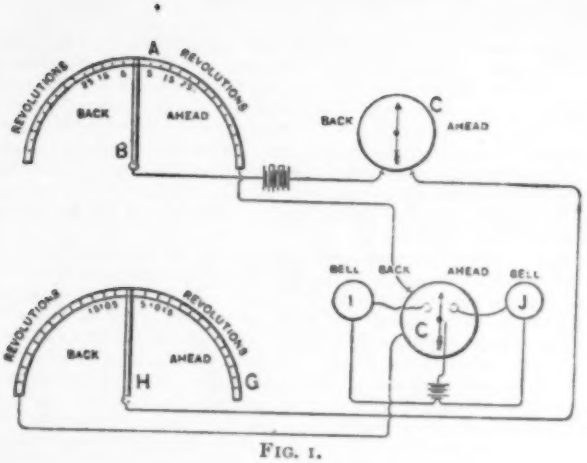

A
REVOLUTIONS
REVOLUTIONS
BACK
AHEAD
B
C
BACK
AHEAD
BELL
BACK
AHEAD
BELL
I
C
J
REVOLUTIONS
REVOLUTIONS
BACK
AHEAD
H
G

FIG. 1.

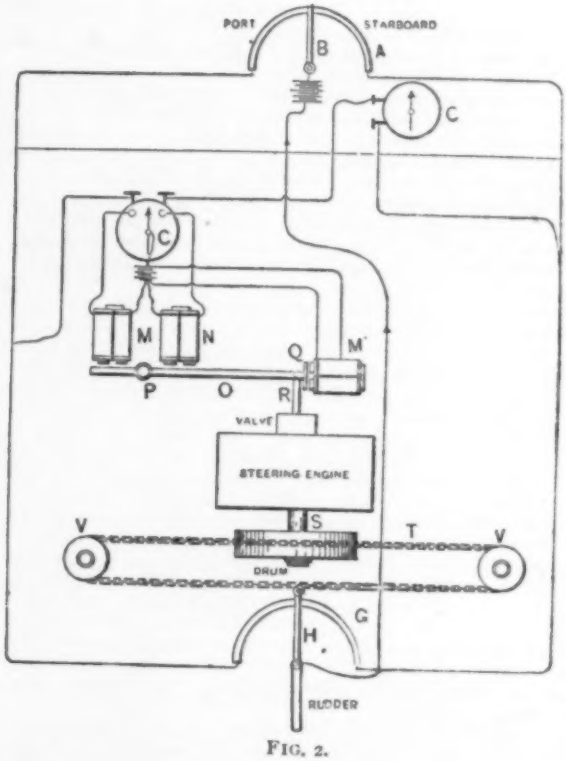

PORT
STARBOARD
B
A
C
C
M
N
Q
M'
P
O
R
VALVE
STEERING ENGINE
V
S
T
V
DRUM
G
H
RUDDER

FIG. 2.

Now suppose further that it be desired to have the vessel go ahead at slow speed. The speed of the vessel for a given number of revolutions being approximately known, the person sending the signal moves the arm *B*, for example, to the mark 15 on the arc *A*. The results already referred to will then occur. The engine-room bell will, however, continue ringing and the needles of the indexes will remain deflected until the engineer re-establishes the balance of the circuit. This he does by moving the arm *H* on his arc *G* to the right to the number 15. He will thus obviously have thrown into the circuit a resistance equal in amount to that by which the total resistance in the circuit had been diminished, thus restoring the normal condition. The needles of the indexes will then return to their normal position, the alarm will cease sounding, and the person sending the signals will be apprised that his order has been exactly complied with. By this device an exceedingly accurate and certain mode of regulating the speed of the ship is at all times available, and confusion resulting from hastily given and but partially understood orders is done away with.

In order to directly control the helm so that the rudder may be adjusted at any exact and desired angle, and also to cause knowledge that the order transmitted has been correctly executed, the apparatus shown in Fig. 2 was devised. It is an automatic means of controlling the helm directly and without the intervention of any one but the person sending the signal.

In this case, as in the one already described, there are two arcs, *A* and *G*, over which move pivoted arms *H* and *B*. These arcs are connected in Wheatstone bridge circuit with a battery and with two indicating instruments, one of which is located at the sending station and the other one near the steering engine which controls the helm. No particular form of steering engine is required; any one of the standard patterns already in use will do. For example, take one that operates a drum, *S*, around which pass chains that are shackled to the tiller *H*, when the engine turns in one direction the tiller moves one way, and when it turns in the opposite direction the tiller moves the other way. The arm *H* on the arc *G* may be the tiller itself or an arm actuated by the tiller.

The two local circuits, which are closed by the movement of the needle of the indicator *C*, in one direction or the other, include electro-magnets, *M* and *N*, which operate a pivoted armature that in its turn moves the reversing valve of the engine. The magnet *M* is connected in circuit to the battery which controls the two local circuits, and serves to center the valve, when the parts are in normal position, as indicated in the diagrams. Now, when is is desired to put the helm in one direction or the other, the person stationed at the arc *A* simply moves the arm *B* in the direction in which it is desired to adjust the helm and also to the desired extent. This immediately disturbs the balance in the circuit, and the fact, as before explained, is shown on the indicator *C'* near him, while the needle on the distant indicator closes one of the local circuits, energizes one of the electro-magnets *M* or *N*, which in turn, attracting the pivoted armature *O*, moves the valve of the steering engine so as to cause it to move the tiller, and hence the rudder, in the desired direction. As soon as the rudder or the tiller *H* moves over its arc to an extent sufficient to re-establish the balance in the circuit, the parts return to their normal position, when the electro-magnet centers the armature and stops the engine. The operation, obviously, is thus entirely automatic, and the ship is steered merely by the movement of the arm *B*.

THE HARVEY PATENTS.

Some details of interest are given in the patents granted lately to H. A. Harvey of Orange, N. J., on the manufacture of armor-plate and guns. The specifications are accompanied by drawings showing the furnace in which the

operation is carried out. The future must tell whether Mr. Harvey can accomplish regularly and uniformly what he has undoubtedly succeeded in doing in isolated cases. Mr. Harvey's cementation process is described as follows:

The armor-plate having been formed of the desired size and shape from a comparatively low steel, such as Bessemer steel or open-hearth steel containing, say, 0.10 per cent to 0.35 per cent of carbon, is laid, preferably flatwise, upon a bed of finely powdered dry clay or sand, deposited upon the bottom of a fire-brick cell or compartment erected within the heating chamber of a suitable furnace. The plate may be so imbedded that its upper surface is in the same plane with the upper surface of those portions of the bed of clay or sand which adjoin the sides and ends of the plate, or the plate may, if desired, be allowed to project to a greater or less distance above the surface of the clay or sand. In either case the treating compartment is then partially filled up with granular carbonaceous material, which, having been rammed down upon the plate, is covered with a stratum of sand, upon which there is laid a covering of heavy fire-bricks. The furnace is then raised to an intense heat, which is kept up for such a period of time as may be required for the absorption by the metal adjoining the upper surface of the plate of, say, an additional 1 per cent (more or less) of carbon, or, in other words, the quantity of carbon, in addition to that originally present, which may be necessary to enable the said metal to acquire the capacity of hardening to the desired degree. The temperature of the heating chamber outside of the treating compartment is brought up to a height equal to or above that required to melt cast iron, and is kept up for a greater or less length of time, according to the depth of the stratum of steel which it is intended to charge with an excess of carbon. This period, however, will, of course, vary according to the efficiency of the furnace.

The degrees of efficiency possessed by furnaces can only be satisfactorily ascertained by actual trial. When ascertained, the reproduction of given results merely requires the re-establishment of the conditions as to time and temperature under which said results have been previously observed to be obtained. This involves merely the maintenance of the furnace at a heat sufficient to melt cast iron for the period which by previous observation has been ascertained to be the period required for adding to the tenacity of the steel and for the supercarburization of the plate to the prescribed extent and depth. For example, a plate, say 10¼ inches in thickness, composed of a comparatively low steel, containing, say, 0.35 per cent of carbon, may be charged with additional quantities of carbon, gradually varying in amount from, say, 0.10 per cent at a depth 3 inches beneath the surface of the exposed side of the plate to 1 per cent at the surface thereof, by a continuance of the treatment for a period of, say, 120 hours after the furnace has been raised to the required temperature.

The statement that the heat at which the furnace is maintained is sufficient to melt cast iron is to be regarded as approximate merely. The more intense the heat the better, and while it will, of course, be understood that the longer the treatment is continued the greater will be the depth to which the carbon penetrates beneath the surface against which the carbonaceous material is packed, it is also to be remarked that the penetration of the carbon is greatly facilitated by the continuous firm compression of the carbonaceous material against the plate. As a general rule, the thicker the armor-plate the greater will be the permissible depth of supercarburization. A 10¼-inch plate and a depth of supercarburization of 3 inches are herein referred to merely for the purpose of illustration.

After the conclusion of the carburizing treatment the plate is taken out of the furnace, and without removal of the carbonaceous material from its surface is allowed to cool down to the proper temperature for chilling. During the cooling operation the carbonaceous material protects the hot supercarburized

surface from the air, and thus prevents the formation of scale, which, if present, would interfere with the subsequent hardening of the metal beneath it. The carbonaceous material, however, may without injurious consequences be temporarily removed from and quickly replaced upon small portions of the supercarburized surface for the purpose of exposing them for observation. When it is seen that the supercarburized surface is so far cooled down as to have a dull cherry-red color, the carbonaceous material is quickly removed, and the plate is then chilled by being sprayed with torrents of cold fluid or by being submerged and kept in motion until cold in a large body of cooling fluid —as, for example, a more or less rapidly running stream or river of fresh water or a tidal current of salt water. The exercise of this precaution insures the subsequent uniform hardening of the supercarburized surface of the plate.

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In consequence of the report of a commission it has been determined to assign wheelmen to staffs and to bodies of troops, without organizing a special corps. The wheelmen are taken from the reserves and kept ready during peace. In war each corps headquarters will have 8, each divisional staff headquarters 4, each brigade 2, each infantry regiment 4 wheelmen, making about 4000 necessary during war. During peace about 2 wheelmen to each regiment are needed. On July 1st of each year a general meeting of applicants for this service will be held. One of the requirements for those assigned to staffs is to be able to make 56 miles in less than 6 hours, and for other posts 31 miles in less than 4 hours.

No. 13. Moltke's field-plan, 1866. Competitive firing between artillery and infantry in Italy.

This competitive target-match took place in the ranges at Cecina. From a battery of six 9-cm. guns 24 rounds were fired in 4 minutes with shrapnel (176 balls) against a battery target at 1600 meters distance. The 6 field-piece targets stood 10 meters apart, the ammunition wagons 15 meters behind; the positions of officers and men of the battery were also indicated by targets. The result of the firing was that 4 officers, 36 men, 6 guns and 3 limbers were hit. And as each man had received on an average 4 hits and each field-piece 8 hits, it amounted to total destruction of the battery. Eight volleys were then fired in 4 minutes by an infantry company of 191 files at the same target, same range. The result was that 8 men, 1 field-piece and 2 limbers were hit with an average of 1 hit each. The ratio of these hits to those of the artillery fire was approximately zero.

No. 14. Moltke's field-plan, 1866 (concluded). Russian artillery drills.

No. 15. The German navy and the Reichstag. The French army, 1891.

No. 16. Nautical retrospect. Observations on naval tactics.

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No. 20. Moltke's military works. New method of exploding spar torpedoes in France. Launch of the Grafton. Speed of torpedo-boats.

The following interesting data on the speed of torpedo-boats of less than 1000 tonnage are furnished by Mr. Yarrow:

Great Britain: Speedy, 21.5 knots; torpedo-boat No. 80, 23 knots. France: d'Iberville, 21.5 knots; torpedo-boats Coureur, Veloce, and Grondeur, 23.5 knots. Germany: Division-boats Nos. 5 and 6, 22 knots; torpedo-boats Nos. 65 to 74, 24 knots; Nos. 76 to 80, 25 knots; Nos. 75 and 81 to 96, 26 knots. Italy: Tripoli, 23 knots; torpedo-boats of Aquila class, 25 knots. Russia: boats of Adler class, 26.5 knots. Austria: boats of Comet and Trabant class, 20.5 knots; boats of Falke class, 22.4 knots. United States: Cushing, 22.5 knots. Argentine Republic: six 130-feet Yarrow boats, 22.5 knots. Chili: Lynch and Condell, 21 knots. China: Schichau boats, 24 knots. Denmark: two boats, 22.1 knots. Spain: Destructor, 21 knots; torpedo-boats of Rayo class, 24 and 25 knots.

Fortifications in Roumania.

No. 21. Naval appropriations. Observations on naval tactics (continued), IV. Rams.

No. 22. Frederick, Napoleon, Moltke, old and new tactics. New French infantry equipments. Reorganization of the Russian navy.

The distribution of the Russian fleet will be as follows: Of the 36 ships of the first class, 28 are assigned to the Baltic, 8 to the Black Sea; of the 48 ships of the second class, 38 to the Baltic, 8 to the Black Sea; of the 88 ships of the third class, 49 to the Baltic, 27 to the Black Sea. 7 ships are assigned to the Caspian Sea, and 5 to Vladivostok; of the 20 ships of the fourth class, 17 are assigned to the Baltic, 3 to the Black Sea. The fleet personnel consists of 2 high-admirals, 11 admirals, 34 vice-admirals, 29 rear-admirals, 285 staff officers and 337 subalterns. The sailors and marines number 30,500.

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No. 24. Studies on science of war. Austrian transportable observation tower. Accident with melinite shell.

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Nos. 29 and 30. The fortified camp in Sicily. Observations on naval tactics (continued), VI. Surprises and protection against torpedo-boats. Telephone during French field-manœuvres.

Nos. 31 and 32. Observations in naval tactics (conclusion). Influence of the repeating rifle and smokeless powder on employment of cavalry. The military carrier-pigeon routes in Europe.

No. 35. Smokeless powder for Swiss artillery. Experiments in France. On the visibility and audibility of the discharge with French smokeless powder.

Rifle.—The smoke of the first shot from a rifle is scarcely visible when the bore is dry; visible at 600 meters when the bore is oiled. The smoke of the second shot is sometimes visible up to 200 meters. With the third shot and beyond no smoke is visible. With volley firing, even the most rapid, the visi-

bility does not increase. At night the flash at discharge is not visible beyond 150 meters. The report is sharper than in the old models. A single report is audible at 200 meters, a volley up to 2500 meters.

Field-piece.—Smoke scarcely visible in daytime, dissipated in 4 to 5 seconds. With a volley the smoke as seen from the side is thicker, but never sufficiently thick to hide the pieces and artillerists. No smoke is visible when the battery fires from behind cover and when three or four meters below and behind the earthwork. When the piece is exposed at a height of 3 meters the flash is visible at 4000 meters. No sign of flash, however, when the piece is placed 6 meters behind an earthwork 6 meters high. At night the flash of discharge appears about twice as great as with the old powder. Not any appreciable difference in the report.

MILITÄR WOCHENBLATT.

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FEBRUARY 17 and 20. A contribution on the history of the French rifle M. 1886. Fortifications of the Gotthard, Switzerland.

FEBRUARY 24 and 27. The field-piece of the future. Two vital questions for the field artillery.

MARCH 2 and 9. Two vital questions for the field artillery (concluded). The Russian navy.

MARCH 16. A French proposition on infantry attack within the effective zone of small-arm fire. Rapid-fire guns in France. The grounding of the Victoria.

MARCH 26. Proof-firing with guns made of Swedish Bofors steel. The new Italian magazine rifle.

MARCH 30. The field-artillery question. Russian cavalry against artillery.

APRIL 23. English rapid-fire and machine guns. Launch of the French auxiliary cruiser Ville de la Civtat.

MAY 7. Cordite. H. G. D.

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MARCH, 1892. The Union cavalry. The shock action of cavalry. Veterinary science for cavalry officers. Organization of cavalry scouts. A Confederate cavalry officer's reminiscences. Mounted infantry. Saddling. Letters on cavalry. Professional notes.

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MARCH, 1892. On the motion of elongated projectiles. Field-artillery fire. Succession list of the master-gunners of England. Steel

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ELECTRICAL REVIEW.

MARCH 5, 1892. The American high-speed engine (illustrated). The transmission of power with special reference to the Frankfort plant.

MARCH 12. Electric lighting of buoys in New York harbor.

. . . In consideration of the fact that the buoys in Gedney's Channel are at the present time the only ones in the world lighted by electricity, a few words in relation to the means adopted to accomplish this result may prove of interest. The channel marked by these buoys is 1000 feet wide and about 6000 feet long, the inner or shore end being about 2¼ statute or 2½ nautical miles northeast from the point of Sandy Hook.

Two lines of heavy-armored three-conductor cables, manufactured by the Bishop Gutta Percha Company, are laid from the Hook Beacon to junction boxes, one on either side of the channel, and situated near the inner buoy on their respective sides. Spliced to these main cables, inside the junction boxes, are three separate single-conductor cables of lighter make, connecting the three buoys on either side of the channel, which are located about 2000 feet apart, with the main line. One of these single-conductor cables is spliced at the lower end of each buoy with the cable running up to the lamp, this wire being laid in a deep slot in the side of the buoy, and covered and protected by a strip of wood fitting closely over it and let in flush with the outer surface.

The buoys themselves are about 50 feet long and are made of a species of juniper wood found in the Dismal Swamp of Virginia, this timber being selected on account of its buoyancy and straightness of growth. They average from 10 to 12 inches in diameter at the top and bottom, and 15½ inches at the largest section, and are shackled at the bottom to a cast-iron sinker weighing 4500 pounds.

The protecting cage, in which the incandescent lamp is set, is composed of flat iron ribs, riveted to two iron bands encircling the spar, with a third ring at the top of the cage which serves as a handle. The upper part of the ribs and the top ring are turned so as to present the edge to the lamp, thus securing greater strength and obscuring light as little as possible.

The lantern itself, which fits securely inside this cage, consists of a circular base and stout framework of brass, having curved panes of thick glass in the sides and segmented panes at the top. It is so constructed that it can be lifted bodily out of the cage, thereby bringing away everything liable to need repair or other attention. Three short legs attached to the bottom ring fit into holes in brass ears riveted to the ribs, and the lantern is secured in place by two hinged screw-clamps, which are also secured to the ribs.

The lamp is rated at 100 candle-power, and the carbon is extra heavy and has three loops in the center, designed to give a distribution of the light as uniform as possible. One terminal wire of the lamp is connected to the bars of the lantern, and the other is carried through an opening having an insulated bushing and connected with the core of the cable. One of the armor wires of the cable is soldered to a rib of the cage to insure a complete circuit through the core of the cable, the lamp and the lantern and frame to the cable armor.

Since the service has been inaugurated, several improvements in minor details which experience has shown to be of value have been made, and to-day the entire working of the plant is as near perfection as it can be brought, considering the difficulties to be contended with. The original heavy lantern has been changed for a lighter one, and straight glass has been substituted for the curved panes first used, so that they can be more readily replaced if broken. The lamp is also so adjusted as to enable it to be taken out without removing the entire frame, if necessary, although the lantern can still be lifted out as formerly, if desired.

The color of the lights has also been changed, or rather they have been differently located, those on the starboard side of incoming vessels being now all red and those on the port side all white, instead of alternating as they were originally.

As an instance of the hard usage to which the buoys and lamps are sometimes subjected, and the excellence of the service rendered under those conditions, it is only necessary to mention that during the severe storm of January last the ice surrounding the lamps was as thick as a good-sized barrel, and the weight of this ice, combined with the heavy sea, was sufficient to keep the buoys for the greater part of the time completely under water. In spite of this, and regardless of the mass of ice surrounding them, the lamps continued to burn brightly and without injury, and, as often as they could manage to get their heads above water, were plainly visible from the shore of Sandy Hook, a distance of nearly three miles.

After passing Fire Island Light, the first objective point of incoming steamers is the Sandy Hook Lightship, which is situated eight miles from the Point of Sandy Hook and about five miles from the entrance of Gedney's Channel. This entrance is marked by two buoys, one of which is a "nun" and the other a whistling buoy, both being placed here as a means of extra precaution in case one should break loose or be displaced in any manner.

From this point the course is west-northwest one-quarter west for a mile and a half through Gedney's Channel, and to a point from which an alignment can be obtained with the Point Comfort and Waackaack Beacons on the Jersey shore. From here the course is west by south through the main channel for a distance of 3½ miles, which brings you inside the Hook and in line with the South Beacon and Sandy Hook Light. A short run northwest by west one-quarter west from here and the Conover and Chapel Hill Beacons come into line, and by keeping them directly astern a straight course can be laid to a point just below the Narrows, from whence it is plain sailing through the upper bay and into the North River.

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OCTOBER 2, 1891. The Royal Arsenal, Woolwich (illustrated). Marine engines of the U. S. Cruiser No. 6 (illustrated).

OCTOBER 9. 150-ton steam traveling crane. Woolwich Arsenal (illustrated). The Snyder dynamite projectile. Willey's boat-lowering gear (illustrated).

OCTOBER 16. On a thermo-electric method of studying condensation (illustrated). Engineers for the Naval Reserve. Triple-expansion marine engine (illustrated). Experiments with compound armor. Bursting of a Krupp gun.

OCTOBER 23. Machine riveting of ships' hulls. Greaves smoke-preventing furnace.

OCTOBER 30. The navy of the United States, No. 1. Electric railways.

NOVEMBER 6. Armor-plate trials at Shoeburyness (illustrated). Nickel-steel armor trials in France and America. Air-pumps. Cruiser No. 6, U. S. navy.

JANUARY 29, 1892. New quick-fire guns for the French navy. The Sims-Edison electric torpedo.

FEBRUARY 5. Probable influence of quick-fire guns on naval tactics.

On Friday, January 30th, Admiral Long read a paper in the theatre of the United Service Institution, on the "Influence of Quick-Fire Guns on Naval Tactics and on Construction." It would be impossible in a short summary to do justice to a paper which dealt with actual tactics and took up supposed courses followed by hostile fleets. For this our readers must consult the proceedings of the United Service Institution when published. It is, however, desirable to notice the general scope and treatment of this important question.

The lecturer began by quoting from *Modern Naval Artillery*, the work brought out last year in connection with the Elswick exhibits, the paragraphs describing the power of quick-fire guns in defeating torpedo-boat attacks. A comparison is made between a ship using three ordinary and three quick-fire guns, and it is pointed out that not only do the latter guns discharge six times as many rounds as the former, but they also have a much better opportunity of striking the enemy, because she moves comparatively little each successive round. About twelve shots a minute is considered the highest practical speed on service, although some guns fire up to fifteen rounds per minute. With cordite or other smokeless powder, the lecturer suggested that a torpedo-boat attempting to get through the zone of fire by daylight was engaged in a forlorn hope. In actions between ship and ship it seems probable that a vessel might be put out of action in half an hour by quick-fire without armor-piercing guns coming into play. This opinion is held not only by the writer of *Modern Naval Artillery*, but also by Mr. White, the director of naval construction.

The change brought about by the introduction of quick fire is made apparent when it is remembered that in 1880 the ram was looked to as the weapon of paramount value. Then the torpedo rose into rivalry with it, until now the combination of quick fire and smokeless powder seems to put the gun into the important place which it held in the days of Nelson. The bearing of this on tactics is obvious. Admiral Bourgois and others have pointed out the advantages to be derived by a vessel attacking with her side presented at 45 degrees to the direction of the enemy's fire, at and beyond which angle projectiles would not bite but glance off. The lecturer then followed the probable movements of fleets attacking in certain lines of order, and discussed how far one ship can render support to another.

The question of side armor naturally suggests itself here. Admiral Long, like many naval officers, has "a soft corner" for a belt carried up to the platform of the guns, so as, at all events, to protect their racers, and hence their power of working. He, however, did not desire to push this question far, as he felt that the relative advantages of each system must be worked out by naval architects. The unprotected condition of a cruiser against quick fire was dwelt upon, and it was pointed out that, as the 6-in. gun was likely to be the heaviest employing quick fire, there seemed to be a special advantage in using armor on heavy ships of the thickness called for to resist this gun. This we might, by the way, point out can hardly be taken lower than 12-in., even allowing for range and some indirectness of impact; in fact, a vessel carrying thicker armor than the Thunderer is needed, and with steel or compound plates instead of iron.

A very interesting point was raised in the now imperfectly protected and

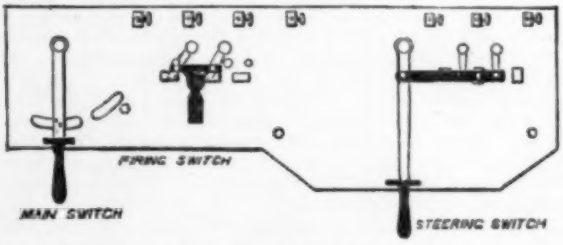
conspicuous position of the conning tower. This, the lecturer pointed out, could hardly fail to be destroyed by quick fire, or at all events the connections from it to the various parts of the ship. He argued, with much reason, that what we cannot protect we ought as far as possible to conceal. Unsatisfactory as armor may be, seeing that it cannot meet torpedo attack, the lecturer thought that the introduction of quick fire and smokeless powder had made it more than ever necessary.

From his review the lecturer concluded that in naval actions it will now be important to develop as heavy a fire as possible for a short time, with a view to which as many guns as possible of adequate power should be mounted. Coals will have to be replenished so often that other stores can be filled up at the same time, and all available weight should be devoted to offensive power. The naval architect's progress is now difficult, seeing that ships are a mark for destruction above and below water. Admiral Long seemed to think that there was much to recommend increased displacement.

FEBRUARY 12 and 19. The Sims-Edison electrical torpedo.

A trial run of the Sims-Edison electrical torpedo took place at Spithead on Wednesday, February 3d, in the presence of H. R. H. the Duke of Connaught and a number of distinguished military officers. The run was conducted from on board the S. S. Drudge.

The controlling switches and other instruments were set up in a small house on the bridge.



On the left is the main switch for putting the current on or off; next to it is the firing switch, held in its normal position by an ebonite safety plug. With the firing switch in this position, main current from the dynamo goes away to the torpedo in a certain direction through the outer core of the cable and works the motor; but if it is put over the other way the current is reversed, and then actuates a polarized relay which sends a shunt current through to the detonator and so fires the charge. On the right is the steering switch, similar to the firing switch, but larger, which controls the current from a storage battery, and sends it through the inner core of the cable in either direction as required. This current actuates the steering relay in the torpedo, causing the main current on its way to earth from the motor to work the steering electro-magnets in the tail of the torpedo. The switch is so arranged that if the lever is set to the right the rudder goes to the right, as also the torpedo; if to the left, the torpedo goes to the left; while if the lever is central, the current is cut off from the steering magnets, and the rudder assumes a central position by the action of the water. On the left of the switch-board are placed a Weston voltmeter reading up to 1550 volts, and an ampèremeter reading up to 50 ampères. Above these is a large resistance box with a controlling handle for putting more or less resistance in the shunt of the dynamo, and so increasing or decreasing the current supplied, and therefore the speed of the torpedo, which may be caused to range almost instantly between 5 and 21 knots at the will of the operator. To the right of the resistance box is a double fuse on the main circuit, for

safety in case of short circuit, and the only other instrument is an electric bell for signaling to the dynamo-room.

All these things having been explained by Mr. Sims, he signaled to run the dynamo, and the men were stationed for launching the torpedo, and the steadying lines were cast off. The Drudge was put to full speed opposite Fort Monckton, and headed toward the Spit Fort, and the order was then given to launch. This was achieved by one man cutting a spun-yarn stop, when the carriage being free to run along on the overhead beam, it started steadily, carrying with it the torpedo with its screw already in motion, and arriving near the end of the beam, the automatic tripper was actuated, and torpedo dropped into the water with a slight dive, going well clear of the ship's side, and the current being increased, it at once gathered way and started off on its journey. As the main object in view was to show the controlability of the torpedo, Mr. Sims did not put on the maximum current, but after running the torpedo to the left on a zig-zag course for a short time to show its steering qualities, he ran it right across the Drudge's bows at a good speed, and finished off with an *S* curve in the direction of Gilkicker Point.

The total length of run was about a mile and a half.

The weather, which had been threatening during the forenoon, improved very much towards evening, which materially assisted the picking up work. The sea was, however, very rough, owing to there being a fresh breeze blowing and to the heavy gales of the preceding three days, notwithstanding which there was no difficulty experienced in launching and controlling the torpedo, which cut its way right through the opposing waves with a force which at times almost completely buried the float, eliciting from the officers a favorable opinion of its power and strength of construction, which should enable it to stand severe weather without injury.

On Tuesday, February 9th, a further trial of the Sims-Edison torpedo took place in Stokes Bay, in the presence, however, of only a couple of visitors. The weather was fine and the sea smooth, and the run was very successful in every way, the steering being perfect and the speed about eighteen knots. It should be noted here that this torpedo has been used continually and much knocked about during the last four years, besides which several additions have been made to it to enable it to be conveniently lifted and launched from a ship, which have all tended to reduce its speed of twenty-one knots previously obtained at Havre, to a lower figure.

All who have had to do with new inventions are well aware that their course, like that of true love, never did run smooth, and if none but successes were chronicled in connection with them, less rather than more confidence in their merits would be inspired.

The next thing, therefore, is to tell of a failure. On Friday, February 12th, a large and distinguished party of officers and others assembled on board the Drudge to witness a trial run in Stokes Bay, the weather being fine and the sea smooth.

After a little time spent in explaining the parts and action of the torpedo, Mr. Sims gave the order to launch, the propeller already revolving in the air at some 700 revolutions. The torpedo moved along the traveler-beam and then plunged into the water, but immediately afterwards it was seen that something was wrong, as it refused to move, and the instruments gave indications of a short circuit in the cable. The picking-up boat was then ordered away to anchor the torpedo, and the Drudge having nearly run out her half mile of cable, the end was slipped and buoyed. Measurements showed that the break was near the junction between the torpedo cable and the ship cable, and Mr. Sims therefore gave orders to cut the cable near this junction, bring the end to the switch-board, and so enable him to run the torpedo from the ship, motionless or at anchor. It was now discovered that, for the first time, and probably because of a larger propeller being used without sufficient guard, the cable had fouled the propeller, and had, of course, been cut. The tube which formerly carried the cable abaft the propeller had been removed after the first trial at New-

castle, as it did not seem to be required, and the guard round the propeller was relied on to keep the cable clear, but it is needless to say that it has now been replaced.

The torpedo was now brought alongside and lifted so as to clear the screw, and then lowered away and towed clear of the ship, and very shortly the current was applied, and it moved away, at first slowly, but very soon getting up a speed calculated at nineteen knots. Now, however, a new trouble occurred, as after answering helm twice, the torpedo would no longer steer, but simply took a long curve to the right, and finally ran close inshore near Browndown, having previously been slowed. It was soon discovered that this trouble was due to no defect in the steering mechanism, but simply to a loose connection of the secondary battery fuze, the terminal having probably jarred loose. This is, of course, instructive, and shows how necessary it is to provide against mishaps trifling in themselves but which may be the causes of so much mischief. As there remained nothing now to be done except pick up the torpedo and cable, the party re-embarked in their respective steamers and returned to harbor, no doubt fully impressed with the idea that the thing is no good. It must fairly be said, however, that although natural under the circumstances, this impression would be an erroneous one, as time, no doubt, will show.

Another run was made on February 15th, which was perfectly successful. The distance covered was something over one nautical mile, and the torpedo was running against a two-knot tide, and was estimated to be going at about eighteen knots through the water. The current at the switch-board was 25 ampères at 950 volts, and the horse-power available at the motor was calculated at about 24.

Military ballooning. Woolwich Arsenal and private manufacturers. French trials of Elswick quick-firing guns. Triple-expansion engines in the mercantile marine.

FEBRUARY 26. Collapsed furnace-crowns of marine boilers.

MARCH 4. H. M. S. S. Ramillies and Repulse.

The engraving which will be found on page 194 gives an excellent idea of what the Ramillies and her sister ship, the Repulse, will be like when finished and at sea. They are both extremely powerful men-of-war; probably the most powerful in the world, not excepting the great Italian vessels. They are steel, twin-screw, double-barbette battleships of 14,150 tons displacement, measuring 380 feet long and 75 feet broad, and having a mean draught of 27 feet and 6 inches. The engines of the Repulse, which are vertical triple-expansion, will develop 9000 horse-power with natural draught, and will drive the ship, it is expected, at a speed of 16 knots. With forced draught they will develop 13,000 horse-power and give a speed of 17.5 knots. The ship will carry 900 tons of coal, which will enable her to steam 5000 knots at 10 knots an hour without refilling her bunkers; but, in case of necessity, she will be able to stow about 400 tons more, and so obtain an anticipated radius of over 7000 knots.

The chief weights to be carried are the armament, 1910 tons, and the armor, 4550 tons. At each end there is a section 65 feet long which is entirely without vertical armor, the only protection there being afforded by a 2½-in. steel deck. The whole middle section of the ship is furnished with a water-line belt of a maximum thickness of 18 inches, 250 feet long, and extending 5 feet 6 inches below and 3 feet above the line of load-draught immersion. The ends of the belt are joined by transverse armored bulkheads which rest upon the armored deck. At each end of the armored enclosure which is thus formed there rises to above the level of the upper deck a barbette composed of 17-in. armor. On the top of the armored belt rests a 3-in. steel deck, and above this, to a height of some feet, the outer walls of the ship are composed of 4-in. steel upon a 1-in. steel skin. Again, above this there is armor in the shape of steel shields to the larger broadside guns. Finally, there are two

armored conning towers, one forward composed of 14-in., and one aft composed of 3-in. plates. Each barbette is a separate and very strong pear-shaped two-storied redoubt. In the upper story is the turntable carrying the guns; in the lower are the turning engines, etc.; and as the whole structure is thickly armored all the way down to 5 feet 6 inches below the water-line, there is obviously little danger of a hostile shell putting the heavy guns out of action by exploding beneath them. The tops of the barbettes project but 2 feet 9 inches above the upper deck; consequently the axes of the guns are only about 4 feet 6 inches above that deck.

The freeboard of the Repulse and her sisters will be 18 feet, and the heavy guns themselves will be 23 feet above the water, instead of 20 feet as in the completed Admirals. The chief armament of the Ramillies and Repulse will consist of four 13.5-in. 67-ton guns, disposed two in each barbette. These have arcs of training of about 200 degrees, and all four guns can be simultaneously discharged on either broadside. The secondary armament will consist of ten 6-in. quick-firing guns of 40 calibers. These are carried in the box battery between the barbettes, two on each broadside being on the main deck in sponsons, and three on each broadside being on the upper deck. The tertiary armament consists of sixteen 2.24-in. 6-pounder quick-firing guns, twelve of which are on the main and four on the upper deck; ten 1.85-in. 3-pounder quick-firing guns on the upper deck and superstructure and in the tops; eight machine guns, and, for landing purposes, two 9-pounder field-guns. There will also be five above-water and two submerged torpedo tubes. The total estimated cost is £831,678.

MARCH 11. The navy of the United States, No. IV.

A description of the "coast-line battleships" and "commerce destroyers," with illustrations. The article includes the following table (see next page):

New Elswick disappearing carriage for 6-in. B. L. gun (illustrated). Ascertaining distances and directions at sea.

This method of measuring distances at sea, devised by H. P. Dowling, "consists essentially in the employment of apparatus for sending sound signals simultaneously through air and through water, and apparatus for receiving and registering the sound so sent, so that the difference in time of arrival through both media may be used to indicate the distance"; the velocity of sound in air and in water being about 1100 feet and 4400 feet per second respectively.

Bounties on ship-building in France.

The navy estimates and ship-building programme.

Table showing Progress made in the Programme of the Naval Defense Act of 1889.

	Total number voted.	To be built by contract.			To be built in navy yards.		
		Total.	Delivered or launched.	To be completed before or in 1894-95.	Total.	Completed.	To be completed before or in 1894-95.
Armored battleship, first-class, *i. e.*, 1 turret and 7 barbette ships	8	4	1	3	4	1	3
Do. second class	2	..	.	..	2	..	2
Protected cruisers, first class	9	5	2	3	4	..	4
" " second class	29	17	11	6	12	2	10
" " third class	4	..	..	..	4	4	..
Torpedo gunboats	18	6	..	6	12	2	10

A Comparison between the most recent Battleships and Cruisers of the United States and Great Britain.

Particulars.	Armored.			Unarmored.			Remarks.
	Indiana, Massachusetts and Oregon.	Centurion and Barfleur.	New York or (Number 2).	Royal Arthur.	Nos. 12, 13. "Commerce Destroyers."	Blake and Blenheim.	
Class or Designation.	Coast-line Battleships.	Second Class Battleships.	Armored Cruiser.	First Class Protected Cruisers.	Protected Cruisers.	First Class Protected Cruisers.	
Displacement, tons	10,298	10,500	8150	7700	7475	9000	
Indicated horse-power, maximum	9,000	13,000	16,500	12,000	21,000	20,000	
Length	348 feet.	360 feet.	380 ft. 6 in.	360 feet.	412 feet.	375 feet.	
Beam	69 ft. 3 in.	70 feet.	64 ft. 10 in.	60 feet.	53 feet.	65 feet.	
Draught	24 feet.	25 feet 6 in.	23 ft. 3¼ in.	23 ft. 9 in.	23 feet.	25 ft. 9 in.	
Speed, knots	16¼ Sea speed 15	18	20	19.50	22 Sea speed 21	22 Sea speed 20	Maximum.
Coal capacity, tons	1800	750 or 1125	1500	850	2000	1500	
Endurance, at 10 knots per hour	16,000*	6500 or 9750	13,500*	10,000*	26,240*	15,000*	Knots *Query?
Side armor, belt	18-in.	12-in.	5-in.	none.	none.	none.	[of deck,
Armor of upper works	5-in.	4-in.		none.	none.	none.	[ness on slopes
Protective deck	3-in. & 2¾-in.	2½-in.	6, 3, & 2¾-in.	5-in. and 3-in.	4-in. & 2½-in.	6-in. and 3 in.	Maximum thick-
Cost	£604,000	£607,746	£597,000	£377,230	£545,000	£433,755	
Armament, guns	4 13-in. B.L.R. 8 8-in. " 4 6-in. " 26 light.	4 10-in. B.L.R. 10 4.7-in. Q.F. 20 light.	6 8-in. B.L.R. 12 4-in. " 16 light.	1 9.2-in. B.L.R 12 6-in. Q.F. 28 light.	1 8-in. B.L.R. 2 6-in. " 12 4-in. " 28 light.	2 9.2-in. B.L.R 10 6-in. " 24 light.	All fitted with torpedo tubes.

With regard to heavy guns, the First Lord gives the following table, showing the progress made in gun manufacture during the year. The total number of guns completed during the year ended December 31st, 1891, was 396, as compared with 240 in the preceding year:

Nature of Gun.	Numbers Completed.
16.25-inch of 110 tons	1
13.5-inch of 67 tons	21
10-inch of 29 tons	10
9.2-inch of 22 tons	19
8-inch of 14 tons	1
6-inch of 5 tons	75
5-inch of 40 cwt.	22
4-inch of 26 cwt.	8
6-inch quick-fire	8
4.7-inch quick-fire	225
Total	390

The number of guns mounted and ready for ships on December 31st was 1623, against 1410 at the end of 1890.

The following table deserves attention, dealing as it does with *personnel* as well as *matériel*:

	1886.	1892.
Ordnance:		
Breech-loading guns (afloat and in reserve)	499	1,868
Light quick-firing guns (afloat and in reserve)	33	1,715
Torpedoes (afloat and in reserve)	820	2,874
Ships (fighting):		
In commission—		
At home—excluding coast-defense ships, gunboats and torpedo-boats	15	21
Displacement tonnage	110,000	154,500
Abroad—total of all classes	96	110
Displacement tonnage	205,800	300,007
Complements—abroad	18,100	23,350
In reserve (ready for commission):		
Excluding coast-defense ships, gunboats, and torpedo-boats—		
Fleet reserve—		
Division A	....	6
Division B	....	11
Old first-class steam reserve	10	2
Displacement tonnage	25,700	82,200
Ships of 15 knots speed and upwards (afloat and building) all classes except torpedo-boats	57	140
Personnel:		
Establishments of officers and men (active list)	61,400	74,100
Numbers of Royal Naval Reserve (officers and men)	18,300	25,500

MARCH 18. The navy of the United States, No. IV (concluded).

Includes description of Cruiser No. 12.

Photographing bullets. H. M. S. Hawke.

The first set of trials was made on March 5th, on an eight hours' run, the speed being determined by log. There was an air-pressure of about .3 inch of water in the stokehold. Under these conditions the engines worked at an average rate of 98.46 revolutions per minute, indicating 10,761 HP, which gave a mean speed of 19.5 knots.

The next runs were made on March 8th, under a moderate forced draught of .44 inch water-pressure. During a four hours' run at an average rate of 102.18 revolutions per minute, 12,521 indicated horse-power were developed, 521 above contract requirement.

Boilers in the navy.

MARCH 25. An unconsidered phase of cylinder condensation. Improved Martin anchor.

APRIL 1. The S. S. Ruahine. The American champion armor-plate. The Serve tube.

APRIL 8. Buoying and lighting tidal rivers, No. 1 (illustrated). On balancing marine engines and the vibration of vessels (illustrated). The vibration of torpedo-boats. A new method of hydraulic propulsion. Steam trials of H. M. S. Sybille.

APRIL 15. The Institution of Naval Architects. The Russian navy. Military aeronautics. Controlled torpedoes.

APRIL 22. H. M. S. Blake. Victor turbines. Speed in the navy. Giant lighthouse lens.

THE IRON AGE.

VOLUME XLVIII, NO. 9, AUGUST 27, 1891. Threading and slotting machine for guns of 8 to 12 inch caliber (illustrated). Breaking the ocean record. The gun works of Krupp, Armstrong, and Canet (illustrated).

The recent bids submitted by the gun manufacturers of the United States for supplying the army with 100 modern high-power rifled breech-loading guns call attention to the manufacture of such ordnance in foreign countries.

The largest gun works in the world are those of Krupp, at Essen, in Germany. The plant complete covers 600 acres of ground and furnishes employment for 11,000 men. Besides the factories, Herr Krupp owns several hundred iron mines in Germany and a half-dozen in Bilboa, Spain, and to these iron mines should be added several coal mines. It is estimated that the daily output from these mines is 3000 tons of coal and 15,000 tons of ore, and that this part of the work employs 6000 workmen. Krupp has 14 blast furnaces belonging to six smelting works. A complete railroad and steamship service forms part of the vast and complex system. There are also hospitals, insurance associations, villages and a complete social organization that go toward making the Krupp establishment a community to itself. This community numbers some 25,000 workers, all more or less engaged in the production of iron and steel. The value of the plant is estimated at not far from $50,000,000.

The second great gun-making establishment of the world is probably that of Sir W. G. Armstrong, Mitchell & Co., of Elswick, at Newcastle-on-Tyne, England. These works claim that in point of importance and extent they have no other rivals than Krupp. The firm not only make artillery, with all its accessories, but also possess excellent shipyards, from which the largest vessels can be turned out, for either the mercantile or naval marine. For all these purposes the Armstrong Company employ no less than 16,500 men.

The most important ordnance establishment in France is that of the Société des Forges et Chantiers de la Méditerranée. This corporation has three factories, one at Havre, one at Marseilles and one at La Seyne, near Toulon. That branch of the works situated at Havre is chiefly occupied with the manufacture of guns, under the superintendence of Mr. Canet, whose great success has given the name of Canet to all the guns now made by him. The number of

workmen he employs is about 10,000. Canet is a rival of Armstrong, though the latter may not think so, and several nations consider his guns as superior.

Russia has a large steel and gun-making plant at Aboukoff, near St. Petersburg, but there are many Krupp cannons in use in the Russian army and navy. There are many other gun factories besides those mentioned above, but their size and capacity are not to be compared with them.

A glance at the largest guns each of the above firms has turned out may be interesting. Krupp has manufactured the largest cannon in the world, 119 tons in weight. Armstrong, Mitchell & Co. follow with a gun of larger bore, but lesser weight, and Canet brings up the foot of the list with a gun of 66 tons. . . The big gun of Germany costs the sum of $144,750. Three of them were bought by the Italians for coast defense use. England's 111-tonner is worth $93,160. Some of them are mounted on board a couple of the new battleships. The smaller gun—that of France—can be bought for, let us say, $50,000. As more details of this monster ordnance may be desired, the following tables are subjoined:

Gun Maker.	Weight. Tons.	Diameter of Bore. Inch.	Powder Charge. Lbs.	Projectile. Lbs.	Muzzle Velocity. F. S.	Muzzle Energy. F. T.	Penetration in Steel at the Muzzle. Inch.
Armstrong....	111	16.25	960	1,800	2,148	57,580	30.8
Krupp.....	119	15.75	727.5	2,028	1,804	45,970	27.1

To make comparison between the guns of the three celebrated gun makers, the same size of gun must be taken—thus:

	Tons.	Inch.	Lbs.	Lbs.	F. S.	F. T.	Inch.
Armstrong....	67.0	13.5	630	1,250	2,025	35,540	26.6
Canet.....	65.8	13.4	616	990	2,300	36,317	29.1

There is no Krupp gun of 13 inches to place with the other two. Krupp's 12-inch gun is the nearest and that is too inferior to enter. The table shows the superiority of the Canet gun.

FEBRUARY 11 and 18, 1892. The Michelson range-finder. Torpedo-net protection.

MARCH 3. Smokeless powders. The Dundon compound steam boiler. The Brown wire-wound gun.

MARCH 10 and 17. Smoke consumption. Legislation affecting marine boilers. William Cramp & Sons Ship and Engine Building Company. American armor (illustrated).

MARCH 24. United States naval steam cutters (illustrated). The submarine cables of the world.

MARCH 31. The Sigua iron mines. Gun-boring machine.

APRIL 7 and 14. The English navy. The firing speed of machine guns. The Serve boiler tube. Uses of aluminium, I.

APRIL 21 and 28. Torpedoes. The uses of aluminium, II. The Zell steel water-tube boiler. Bethlehem barbettes.

ENGINEERING.

FEBRUARY 5, 1892. Canet vs. Krupp guns. Quick-firing guns in the navy. Steam trials of H. M. S. Edgar. H. M. S. Grafton.

FEBRUARY 19. Trial of H. M. S. Edgar. Military ballooning.

MARCH 4. The life-saving and salvage steamer Aid. H. M. battleship Ramillies. Railways in war-time.

MARCH 11. The training of Royal Naval engineers. 30.5 centimeter cast-iron howitzer.

This 12-inch cast-iron built-up howitzer was constructed at the Fabrica de Trubia, Spain. It was designed by a Spanish artillery officer and passed satisfactory tests. The breech of the gun is built up of steel rings shrunk over the cast-iron A-tube, while the breech mechanism is on the interrupted screw principle. The principal dimensions are, caliber 12.01 inches, weight 14.27 tons, length of bore 12.5 calibers, preponderance 132.23 pounds, weight of charge 77.16 pounds, volume of chamber 3051 cubic inches, weight of projectile 606 3 pounds, initial velocity 1129 feet, range for 45 degrees 10,717 yards, number of grooves 48.

The navy estimates. Combined centrifugal and positive action pumps.

MARCH 18. The construction of theoretical indicator diagrams for compound engines. Modern United States artillery, No. I (illustrated). Steam boiler experiments, No. VIII. Navy boilers. Breakdowns in the navy.

MARCH 25. Formosa and its railways. Modern United States artillery, No. II (illustrated).

Description of standard light 3-inch rifle, of converted 8-inch and 10-inch smoothbores, as well as of projectiles for converted guns.

The employment of ships. How fast a single-barrel machine-gun may be fired.

APRIL 1. Modern United States artillery, No. III (illustrated).

Converting wrought-iron 3-inch guns; description of manufacture of 3.3-inch steel B. L. R., model 1889.

Canet vs. Krupp guns. The Serve boiler tube.

APRIL 8. Modern United States artillery, No. IV (illustrated).

Description of breech mechanism of 3.2-inch B. L. R., model 1889.

Balancing of marine engines and the vibration of vessels. Water-tight bulkheads. Circular furnace-stoker.

APRIL 15. Modern United States artillery, No. V (illustrated).

Description of carriage, limber, and harness for 3.2-inch B. L. R.

Institution of Naval Architects. Steadying vessels at sea. Whale-back steamers. An approximate rule for the center of buoyancy. Vibration of vessels. Balancing of marine engines and the vibration of vessels (illustrated). Water-tight bulkheads (illustrated).

APRIL 22. Modern United States artillery, No. VI (illustrated).

Description of 3.6-inch heavy field-gun, its ballistic data, ammunition, fuzes.

Institution of Naval Architects. Field howitzers and mortars.

ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE.

NINTH ANNUAL SERIES, 1891, VOLUME XII. Hydrographic notes on New Guinea. Agreement of weather characteristics in northern

Germany (concluded). Tides and currents in the roadstead of Hangkow in the Yantse Kiang. Currents and sea temperatures on the west coast of South America. Sailing directions for Zanzibar. Report of Captain F. Duhme, of the German steamer Tai-cheong, on the typhoons of July, 1891. Extracts from the reports of the masters of ships Aeolus and J. W. Gildenmeister (notes on ports in various parts of the Pacific Ocean, as well as on the passage through Torres Straits). Voyages in the Gulf of California and along the west coast of Mexico. Deep-sea soundings in the East Indian archipelago. On the effect of the direction of the wind and atmospheric pressure upon the surface of the sea; Chronometer comparison based on their methods of compensation. Quarterly weather review of the German Naval Observatory, spring of 1887. Minor notices: Remarkable meteoric phenomena; Anchorage for war-vessels in the harbor of Piraeus: Anchorage on north side of Pajaros Island, Mexico; Antofagasta.

THE UNITED SERVICE.

APRIL, 1892. The building of the soldier. Priscilla. A lesson from history. Riots and means for their suppression. Street fighting, by Henry Romeyn, Captain 1st U. S. Infantry. Capture of the United States revenue cutter Surveyor. Company discipline. Marbot.

MAY. Wagon and rail transportation. Recollections and incidents of a cruise around the world. Napoleon the Third at Sedan. History of first fight and organization of Stonewall Brigade. Civil employment of troops. Chronicles of Carter barracks. The captain's story. Captain T. O. Selfridge, Jr., U. S. Navy.

JOURNAL OF THE MILITARY SERVICE INSTITUTION.

MARCH, 1892. Position-finding service. Army transportation. Was Gettysburg decisive? Artillery service in the Rebellion. Infantry fire. Shrapnel fire. Power of military courts to punish for contempt. Reprints and translations: The progress of tactics; Smokeless powder; Coast and harbor defense; Canet vs. Krupp guns; Changes in military matters; Letters on infantry, XIV. Military notes: The German torpedo-shell; Mannlicher bullets; Coast batteries.

MAY. The military geography of Canada. Artillery in the Rebellion. A plea for the colors. Diseases which have been epidemic in armies. Post schools in the army. Reprints and translations: Military small-arms; The progress of tactics; Staff duty in the Peninsular army; Letters on infantry; Experiments with field mortars. Military notes: Modern military rifles; Photography and reconnoissance; Improvement of Scott's telescopic sight; The Krag-Jörgensen rifle.

FRANKLIN INSTITUTE.

MARCH, 1862. Bearing-metal alloys. The proposed ship-canal between New York and Philadelphia, connecting the Delaware and Raritan rivers. The development of spiral weld tube machinery. Philadelphia as a seaport, by Capt. F. A. Mahan, U. S. A. Electrical section: An early conception of the magnetic field; Notes on electro-magnetic machinery, by Wm. S. Aldrich.

APRIL. Aluminium, its manufacture and uses, from an engineering standpoint, by A. E. Hunt. Philadelphia as a seaport. A computation of Joule's equivalent (concluded). Chemical section. Electrical section: Resistance standards, their manufacture and adjustment; On the variable action of two-coil solenoids. Photographic novelties.

BULLETIN OF THE AMERICAN GEOGRAPHICAL SOCIETY.

VOLUME XXIV, No. 1. Exploration of the Grand River, Labrador. Who discovered the Pygmies? Rivers and the evolution of geographic forms. U. S. atlas sheets and census bulletins. Geographical notes.

UNITED SERVICE GAZETTE.

MARCH 5, 1892. Photography and reconnoissance. Launch of the Repulse and of the Ramillies. Carrier pigeons.

The census of carrier pigeons taken in Paris between January 1st and 15th last shows that there are 697 proprietors, possessing 13,892 birds. The census enters into very minute particulars as to the respectability of the owners, and the direction in which the pigeons are trained to fly, so that in case of war the military authorities on taking over the birds would be in a position to utilize them to the best advantage.

MARCH 12. Naval gunnery.

"Before allowing a seaman to fire he should be put through a course of drill which should be most carefully carried out; and no man ought to be allowed to fire a shot until he has proved himself efficient at drill. . . . . The executive officer may be said to take no interest whatever in anything appertaining to gunnery. It dirties his paint-work and boats, interferes with his routine, and occupies men who would otherwise be at his disposal; so he gives the men with a bad grace, often remarking that gunnery is 'all rot.' This officer and the gunnery lieutenant are, therefore, generally working at cross purposes, and the former will often put serious obstacles in the way of the drills, and the men who are under instruction are made to feel that if not employed in that way they might be at leisure, the result being a cordial hatred of gunnery drills. It is a curious fact that executive officers who have themselves been gunnery officers are frequently antagonistic to their old chosen specialty; gunnery has been to them a stepping-stone to promotion and is now of no further interest. The executive officer is not alone to blame in this matter. It must be remembered that his promotion depends almost entirely on the general appearance of his ship, its cleanliness, and the efficiency of the ship's company apart from gunnery.

The only remedy that suggests itself is that there should be a senior officer on the staff of the admiral in each squadron appointed for the superintendence of gunnery drills and exercises."

The Russian navy. The terrain in its relations to military operations, IV. The navy estimates. Quick-firing guns in the French army.

MARCH 19 and 26. Naval manœuvres of 1891. The use of pigeons for naval and military purposes. The Royal Naval Reserve. Ships, engines and boilers.

Apropos of the rapid diminution which has been made in recent years in the bores of military rifles, the *Revue Scientifique* gives the following table of rifles which have been adopted since 1866:

State.	Year.	Caliber. mm.	System.
France,	1866	11	Chassepot.
United States,	1866	11.43	Springfield.
Belgium,	1867	11	Albini.
Austria,	1868–73	11	Werndl.
Switzerland,	1868–81	10.4	Vetterli.
Spain,	1871	11	Remington.
Germany,	1871	11	Mauser.
England,	1871	11.43	Martini.
Holland,	1871	11	Beaumont.
Italy,	1871	10.4	Vetterli.
Russia,	1871	10.66	Berdan.
France,	1874	11	Gras.
Portugal,	1885	8	Gnédes.
France,	1886	8	Lebel.
Austria,	1888	8	Mannlicher.
Germany,	1888	7.9	Mannlicher.
England,	1889	7.7	Lee-Metford.
Belgium,	1889	7.65	Mauser.
Switzerland,	1890	7.5	Mauser.
Italy,	1892	6.5	Mauser.

APRIL 2. Launch of the Crescent. Naval notes: Launch of the Bouvines.

The Bouvines has a displacement of 6610 tons, 284 feet between perpendiculars, breadth 55 feet, draft 24 feet 4 inches. She has two sets of triple expansion engines, giving 7500 HP and a speed of 15 knots. The hull has an armored belt of 17¾-inch plating; the steel deck varies from 2¾ to 3.9 inches in thickness. Her armament will consist of two 32-cm. guns mounted in heavily armored hydraulic pivoted turrets, eight 10-cm. quick-firing guns, eight 38-mm. revolving guns and two 47-mm. machine guns in the tops.

APRIL 9. The shooting of field artillery. Institution of Naval Architects. The Royal Naval Reserve.

APRIL 16. Field artillery tactics. Field howitzers and mortars.

APRIL 23. The physique of the army. Quick-firing guns. The use of balloons in warfare.

JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION.

APRIL, 1892. The telephone at home and in the field. The reconnoissance of a railway; its utilization and destruction in time of war. The naval prize essay, 1892: "Maritime supremacy being essential for the general protection of the British Empire and its commerce, to

what extent, if any, should our naval force be supplemented by fixed defenses at home and abroad, and to whom should they be confided?" by Captain R. W. Craigie, R. N.

The writer first considers the question of defenses ashore in England. According to the relative importance of the ports to be guarded, the defenses are ranged under four classes. The floating coast defenses are next considered, followed by the fixed defenses abroad. The different trade routes of England are taken up in order and the needs of defenses are thoroughly considered. The essay winds up with the following conclusions:

"1. That to the Navy should be entrusted the duty of sweeping the high seas and of keeping them clear of the enemy's cruisers.

2. That, after our maritime supremacy has been assured by building a sufficient number of ships, our naval force should be supplanted by certain fixed defenses raised to meet a definite purpose at our different ports at home and abroad; this purpose being to resist a raid or attack by one or more cruisers for a few days, and to offer a safe refuge for our war-ships and mercantile marine while coaling, loading or unloading, or under repair.

3. That these fixed defenses are of little use, since they could not keep the entrance of the port clear, or prevent the attack of torpedo-boats, without a floating defense, consisting of torpedo-boats and armed local steamers acting as guard-boats.

4. That these fixed defenses should be under military control, but that all the purely naval or maritime portion of the defenses should be manned and worked by seamen under a naval officer attached to the staff of the general officer in command.

5. To avoid, however, breaking up regiments into small detachments unnecessarily, certain small coaling stations abroad should be manned by marines and seamen and placed under naval control.

6. That the only way that our naval and military forces can be kept in their proper proportion, and used with the greatest effect, is to place them both under one minister."

Essay honorably mentioned: "The employment of Photography in reconnoissance." Modern rifle bullets and their effects. The naval schools of the chief continental powers, Part III.

TRANSACTIONS OF THE TECHNICAL SOCIETY OF THE PACIFIC COAST.

Vol. IX, No. 1. The commerce of San Francisco, with discussion, George W. Dickie.

MÉMOIRES DE LA SOCIÉTÉ DES INGÉNIEURS CIVILS.

REVUE DU CERCLE MILITAIRE.

FEBRUARY 14, 1892. Surgical antisepsy in the army.

This is the title of an unpretending but useful memorandum pocket-book that can be easily consulted even on the battle-field.

Notes on the Austro-Hungarian army. Adaptation of the commissariat wagons to ferry-boats for the passage of troops over streams and narrow waters.

FEBRUARY 21. Surgical antisepsy in the army (continued). Notes on the composition and organization of the Austro-Hungarian army.

FEBRUARY 28 and MARCH 6. Antiseptic operations and dressing in the army (with sketches).

MARCH 13. Interior life of the private in the English army. Organization of the reserve in the Portuguese army.

MARCH 27. Military strength of Morocco. Antiseptic operations, etc. (continued). Notes on the Austro-Hungarian army (ended).

APRIL 10. Practical instruction in the military academy of Toledo (Spain). A study on infantry tactics, continued from the preceding number. Antiseptic operations, etc. (ended).

APRIL 17 and 24. A study on infantry tactics (ended). The adjustable boat of Lieutenant Van Wetter of the Belgian army.

A full description of this contrivance will be found in this and the following number of the Review. It is destined to render great service and unites the following advantages: 1, great strength; 2, minimum weight and facility of transportation; 3, small volume; 4, rapidity in taking apart and putting together; 5, possibility of the wood-work being built and all repairs made by the troops; 6, smallness of cost; 7, keeping in repair next to nothing.

MAY 1. The "lava" of the Russian Cossacks and their modes of fighting. Use of railroads during the Turko-Russian war (continued). New firing regulations in the Italian army. The crossing of streams during army operations.

This is one of the important problems that preoccupy the minds of military men, which assertion requires no better proof than the numerous articles lately written on the subject (see article published in the Revue of April 24).

LE YACHT.

JANUARY 30, 1892. Transformation of the 28-caliber gun into a R. F. cannon. A proposition to turn over the coast defenses to the unemployed part of the naval reserve, in case of mobilization.

FEBRUARY 13. A lecture by Rear-Admiral Sam. Long on the influence of the rapid-fire gun on naval tactics. A new system of screws devised for engines turning in the same direction.

FEBRUARY 20. The Russian navy. Of the necessity of establishing electric communication between the semaphoric coast-stations. On the use of aluminium in yacht-building.

FEBRUARY 27. The R. F. gun. "Union of French Yachts": Admissions; Regulations for the Cup of France; Programme of 1892.

Thinking that the regulations governing the race for the Cup of France might prove of interest to yachtsmen on this continent, we give below a translation of the same:

Art. I. The Cup of France, founded by the "French Yacht Association," and transferred to the "Union of French Yachts," constitutes the prize for an international race, to be sailed on and after the year 1892, and which can be entered by all yachts conforming with the following rules:

Art. II. The cup is and shall remain the property of the Union. Its possession by the owner or owners of the winning yacht shall be only temporary.

Art. III. The race for the cup shall be sailed in French waters between July and October, and at a place designated by the Union before the 1st of March in each year.

Art. IV. The regulations governing the race shall be those of the Union of French Yachts.

Art. V. Shall be admissible to compete in the race, yachts of all nations, with any kind of rig, standing keel, or center-board, whose tonnage shall be superior to 5 tons, and not over 20 (French measurement).

Art. VI. Foreign yachts in order to be qualified must have been built in the country whose flag they display.

Art. VII. Shall be admitted to compete, only those French yachts whose plans have been designed by a French builder, have been built and equipped (including sails) in France, and shall be manned by a French crew.

Art. VIII. Foreign yachts intending to proffer a challenge must give notice of their intention before the 1st of April of each year.

Art. IX. Yachts intending challenging a foreign club holding the cup must also notify the fact through the "Union of French Yachts," and at the same date as in Art. VIII.

Notices of challenge shall furnish. 1, the name of the owner; 2, that of the yacht; 3, the necessary dimensions for measurements, or a certificate delivered by the Union; 4, the yacht's rig, her origin, and her date of construction, whether of wood, iron, steel, or composite; a fac-simile of her racing pennant, and finally, an honorable pledge not to contest before tribunals any point of difference arising from possible incidents of the race, and to sign, if need be, a pledge of amicable arbitration.

Art. X. A challenge having been forwarded to the holder of the cup, the latter shall forthwith give the names of the yachts accepting the challenge, and this before the 1st of June of each year.

Art. XI. If no challenge shall have been received before the 1st of April, the race will be postponed till the following year. Should none of the yachts having sent the challenge present themselves at the starting point, then an adjournment shall likewise take place.

Art. XII. Should no yacht take up the challenge, the cup will be handed to the yacht having sent the challenge. Should there be several yachts entered for the race, they will sail over the course to determine the victor, the same as if the challenge had been taken up.

Art. XIII. The course shall be sailed over three times in succession. The details will be published every year in a special programme made out by the Union of French Yachts. Each trial will be over a course of not less than 20 nautical miles, and the yachts shall sail over it at mean rate of 3 miles an hour, otherwise the race shall be declared off. The yacht reaching the stake first in two runs shall be declared the winner; if she should win the first two, the third will be dispensed with.

Should each run be won by yachts of different nationalities, or several yachts of the same nationality, the final victory shall be decided by a fourth race.

If two out of three runs shall have been won by different yachts of one nationality, the final contest shall be only between those yachts.

Art. XIV. The challenging club, or the Union of French Yachts, will present the cup to the victorious yacht, whose owner will furnish the necessary security.

Art. XV. The start will take place exactly at the hour fixed, except 1st, in case of some extraordinary circumstance; 2d, in case of a mishap just before the start, in which case the judges will decide whether sufficient time shall be granted or not to repair damages.

Art. XVI. The Union of French Yachts will entrust to a local nautical society the management of the race.

Art. XVII. The Union of French Yachts reserves the right as long as said Union or a Frenchman shall hold the cup, of modifying or changing the conditions of the race before the 1st of February in every year.

Art. XVIII. Letters of challenge shall include a pledge to pay the entrance fee indicated in the programme.

The use of aluminium in yacht-building and its results compared with wood or iron in sailing yachts (see preceding number.) The French armor-clad Jauréguiberry, built at La Seyne by the Forges et Chantiers de la Méditerranée.

MARCH 12. The naval appropriations for 1893 in the French Parliament. A comparison between the English and French armor-clads.

MARCH 19. The English naval budget. A comparison between the English and French armor-clads (concluded).

MARCH 26. The English naval budget in the House of Commons.

APRIL 2. A projected law in regard to the "inscription maritime." Launching of the armor-clad Bouvines. Geometry of the yacht; formula of measurement (see preceding number).

APRIL 9. The navy; the budget; the North squadron; Dahomey; Rear-Admiral Mottez (E. Weyl). Geometry of the yacht; formula of measurement (continued).

APRIL 16. The coast defenses of France. The English first-class cruiser Edgar.

APRIL 30. The navy and Dahomey. The next naval appropriation. The new constructions (E. Weyl). The Maxim-Nordenfelt guns. Launching of the armored coast-defense vessel Jemmapes.

REVUE MARITIME ET COLONIALE.

MARCH, 1892.

The greater portion of this number is taken up with two articles translated from the English, the first being "Problems of Greater Britain," under which title Sir Ch. Dilkes published two years ago, as our readers are probably aware, an exposé of the situation of the British Empire. The second is a translation of the "Latest Great Naval War," the famous production of Mr. Nelson Seaforth.

The boards of administration of navy years (French), ended.

APRIL —. Oceanography [dynamics] (continued). Considerations of the relations between the barometer and the distribution of air-currents. A study upon the mechanical theory of heat. A vocabulary of powders and explosives (continued).

BOLETIN DEL CENTRO NAVAL, BUENOS AIRES.

NOVEMBER, 1891. Military jurisprudence.

An appeal from the action of the Minister of Marine in ordering the arrest of the president (a commodore) and members of a court-martial.

DECEMBER. A relation of the practice cruise of the Argentina during a surveying expedition on the coasts of Patagonia.

JANUARY, 1892. Cares and precautions in the management of chronometers on board ship. Naval guns.

An article in which the author criticises severely the Armstrong and Krupp manufactures of heavy ordnance, adducing as proof of their indifferent quality a numerous list of accidents which have occurred with their system during the last decade.

Continuation of the relation of the practice cruiser Argentina on a surveying expedition to the coasts of Patagonia. Defense of seaport entrances against torpedo-boats. Organization of the Argentine fleet.

REVISTA MARITIMA BRAZILEIRA.

DECEMBER, 1891. Report of the results of Lieut. Portella's visits to European dockyards and shipbuilding establishments to the Brazilian minister of marine; followed by a few notes on the institution of naval apprenticeship among various nations. Smokeless powders in naval battles (translated from the French).

The government manufacture of smokeless powder at Sévran-Livry furnishes powder to the French army and navy. Mr. Canet uses for his guns powder of the above manufacture, adding to it an innocuous substance in order to frustrate any chemical analysis that might be attempted to discover its composition.

JANUARY AND FEBRUARY, 1892. Report of Lieut. Portella (continued). A few notes on the institution of naval apprenticeship among different nations (continued). Smokeless powder C. 89 used by Krupp. A new method of rectifying a table of deviations of the compass.

NAMES OF MEMBERS WHO JOINED SINCE JULY 1, 1891.

LIFE MEMBERS.

Clowes, W. Laird, Prize Essayist, 1892, No. 4 Wyburn Villas, Surbiton Hill, Surrey, England.
Maxwell, W. J., Ensign, U. S. N.

REGULAR MEMBERS.

Brainard, F. R., Ensign, U. S. N.
Dutton, Robert McM., Lieut., U. S. M. C.
Hayes, C. H., Asst. Engineer, U. S. N.
Lowry, O. W., Lieut., U. S. N.
Martin, John R. P., Asst. Paymaster, U. S. N.
McDonald, J. E., Naval Cadet, U. S. N.
Scales, A. H., Ensign, U. S. N.
Snow, T. H., Naval Cadet, U. S. N.
Snow, W. A., Ensign, U. S. N.

ASSOCIATE MEMBERS.

Clapp, T. H., Ensign, Naval Battalion, M. V. M.
Fitzgerald, John J., Lieut., Naval Battalion, N. G., California.
Graham, Geo. H., Counselor at Law.
Hamilton, James, 2d Lieutenant, 3d Artillery, U. S. Army.
Harvey, H. A., Gen'l Manager, Harvey Steel Co.
Rowan Hamilton, 1st Lieutenant, 2d Artillery, U. S. A.
Slater, A. B., Jr., Superintendent, Providence Gas Co.
Smith, F. G., Major, 4th Artillery, U. S. Army.
Sweet, Henry N., 4 Spruce Street, Boston, Mass.
Wadagaki, Y., Japanese Student, London, Eng.
Weaver, E. M., 1st Lieutenant, 2d Artillery, U. S. Army.
Wilson, Thomas L., Electrical Engineer.